APR 1982

# eti

ELECTRONICS TODAY INTERNATIONAL

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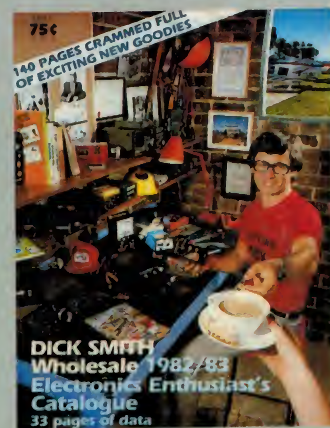
## DICK SMITH CATALOGUE




**Check Inside**

# ROBOT TO BUILD

## SPECIAL OFFER

**Tasman Turtle Robot Kit**

**Programming the'660 in Colour**

**Sansui TU-S33 Tuner Reviewed**

**`CIRCUIT FILE´ New Feature**

**Percussion Synthesiser Project**

**Toolkit and Tools to Win in`Minitools´Contest!**

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Roger Harrison
Editor

# QUICK INDEX

# advertisers




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Robotics becomes all the rage! This issue features construction details for the 'Tasman Turtle' robot shown on the cover plus a special offer on kits for this project on page 37. ('Tasman Turtle' is a registered trademark of Flexible Systems).

Cover design by Ali White and Githa Pilbrow.

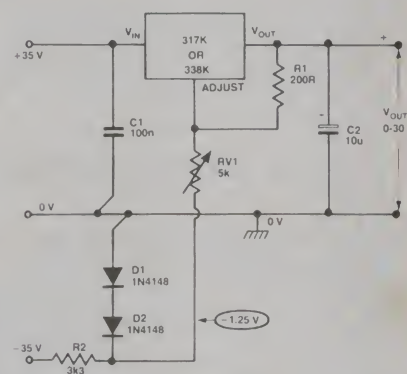
*Recommended retail price only

# news



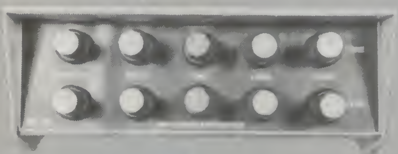
# features








# projects



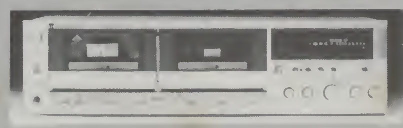


## computing





## sight & sound

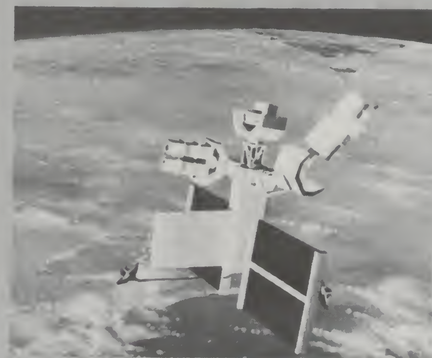




## general



## next month



### STARLAB
The Starlab Australian-Canadian UV Telescope Project is likely to be one of the most exciting things to happen to Australian Science until well into the next century. It promises to revolutionise our knowledge of the universe, while assuring Australian astronomers a place in the front rank of world astronomy.

### ETI-670 ASCII KEYBOARD
Sorry, folks, but production problems have forced us to delay this project a month. Don't miss the May issue if you're waiting on this one.

### PUBLIC ADDRESS AMP.
Built around the ETI-499 150 W MOSFET module, this public address system will drive 4 ohm loads or standard 70 V/100 V lines for horn speaker systems. Provision for several mic inputs and a line input has been included and you can add on our ETI-486 Howl-Round Stabiliser for feedback control.

### TURTLE ROBOT — MORE
The Tasman Turtle Robot project continues with mechanical construction, plus electronics and controller. Get into robotics, it's the coming thing!

### B&W DM12 SPEAKERS
Bowers & Wilkins set out to develop a 'mini monitor' system with some of the attributes of their illustrious Model 801s — and seem to have come quite close to the mark. See what Louis Challis has to say.

**Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.**

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**WHYALLA, SA: Mellor Enterprises**
Shop 2, Forsythe Street, Phone: 45 4764

**These are our major dealers, however we cannot guarantee they will have all these items in stock and at the prices advertised.**

DSE/A209

# Australia to New Zealand on 1296 MHz!

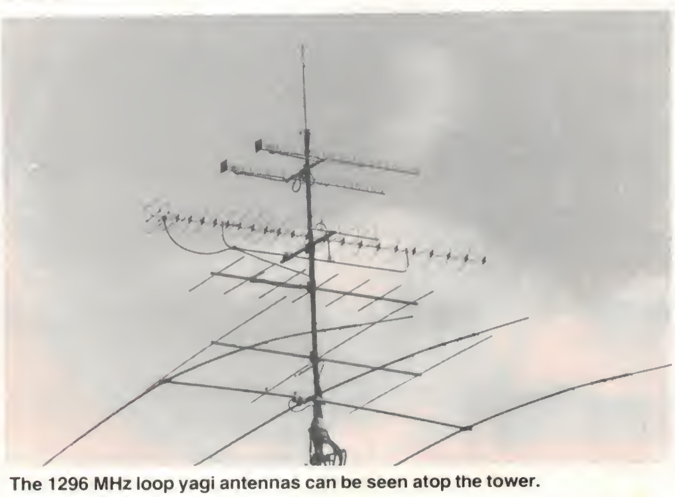
Dick VK2BDN and his well set-up station.

## — world record claimed

On the morning of 9 February last, a Sydney radio amateur, Dick Norman VK2BDN, contacted a New Zealand amateur, Brian ZL1AVZ, on 1296 MHz — gaining not only a first for spanning the Tasman on that band, but possibly a world record to boot!

**The current world distance record for this band stands at 2107 km, held by VK5MC and VK6KZ (set on 29.12.78). The distance between VK2BDN and ZL1AVZ is calculated to be 2134 km. If confirmed, the two operators will hold the new world distance record for this band.**

The action started on 25 January at 1920 Eastern Australian Summer Time when Dick Norman received a phone call from New Zealand stating that the two metre band (144-148 MHz) was open between eastern Australia and New Zealand. Dick promptly got going on 432 MHz and worked ZL2VT, the contact lasting for over an hour.


The 1296 MHz loop yagi antennas can be seen atop the tower.

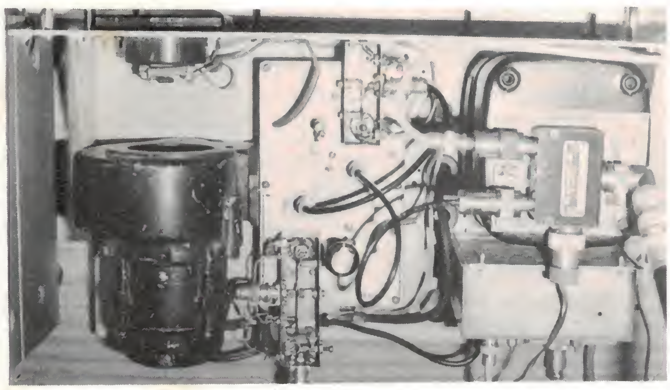
He also worked ZL2TAL, ZL2-THG and ZL1TBG. Signals were peaking to S8. This band was still open at 2200 local time.

A similar opening occurred on 8 February, with signals to strength nine (S9), lasting until after midnight. The next morning (9 Feb.), Dick tried 432 MHz and contacted ZL1AVZ at 0630 local time. As signals were readability five, strength nine (5 x 9 — or 'clear as a bell') the New Zealand station suggested trying 1296 MHz. Dick, VK2BDN, ran carrier on 1296 MHz whilst he had breakfast. At 0745 Sydney time, Brian ZL1AVZ reported on 432 MHz that he was receiving Dick's 1296 MHz carrier.

Dick then called on 1296 MHz SSB and a two-way contact to ZL1AVZ ensued over a period of 20 minutes. Brian, ZL1AVZ, used CW and SSB. Dick received Brian at 5 x 2, Brian received Dick at 5 x 3.

The contact, apart from possibly establishing a few new records, was remarkable when you consider the equipment. ZL1AVZ was running a Microwave Modules transverter and a 4 m diameter dish. VK2BDN was using a 'homebrew' 2C39 (lighthouse tube) mixer driving a 2C39 linear amplifier. His receiver employed a Microwave Modules preamp and converter, 144 MHz IF. Antennas were two 27-element loop yagis. QSL cards have been exchanged.

Dick received assistance and encouragement from Geoff Campbell, VK2ZQC. Well done, gentlemen! Dick's next attempt will be on 2300 MHz.


Inside the 1296 MHz transverter; transit mixer and amplifier in the centre, receiving converter at lower left.

## Space age plastic for coax seals

**Coax-Seal is a new 'space age' plastic material which is said to seal all types and shapes of coax fitting quickly and effectively.**

It is claimed to stay flexible for years, ensuring moisture-proof connections, good SWR and long coax life. It allows quick disconnection and resealing of fittings, and will adhere to vinyl and polyvinyl coax outer covers.

Coax-Seal may be used to seal through wall runs, on baluns, beam antenna parts, dipoles and connections, and is non-toxic, non-conducting, non-corrosive and versatile.

Coax-Seal is supplied in industrial rolls, 1/16" x ½" wide (1.6 x 12.5 mm) on peelable backing paper, 50' (15.25 m) roll for use by CATV installers, microwave work and other installation uses.


# New Univolt digital multimeters

**Two new handheld multimeters from Univolt have been released here recently through IFTA, who hold the Univolt agency.**

Model DT-830 features a single large rotary switch for range selection, 30 measurement ranges, transistor and diode checkers, a continuity 'beeper' and a 3½-digit liquid crystal display. On ac and dc voltage ranges it covers 200 mV to 200 V in four steps, plus an extra step to read 1000 V on the dc range and 750 V on the ac range. On dc and ac current, the DT-830 covers 200 uA to 10 A. It has six resistance ranges from 200 ohms to 20 M full scale. Projected retail price is $90 or so.

The DT-840 is an autoranging instrument featuring 20 measurement ranges, including a 'low ohms' range, with beeper. The DT-840 also features a 3½-digit LCD like the DT-830, and has a simple four-position switch in the front to select the quantity to be measured (volts-resistance-current). This one is expected to retail for $45 or so.

We've had the opportunity to use and evaluate these instruments here at ETI and found them well-made, easy to use and accurate. The DT-830 makes a very handy lab or bench instrument, while the DT-840 is an excellent instrument for the general experimenter or service technician. They're worth a jolly good look if you're after a digital multimeter.

Further details from IFTA, P.O. Box 21, Bondi Beach NSW 2026. We note they also have a range of analogue multimeters to suit a variety of applications and budgets.

## ERRATA

**Short Circuits, Autostart & etc for ETI-730 RTTY Decoder:** the author, Ralph Youie, writes: "I draw your attention to an error indicated to me by Ken, VK3ALC, on page 64 of January 1982 ETI. All references to Q1 in the article should refer to Q2, BF338, as there is no way that the circuit will work as shown. If there are difficulties in obtaining the correct waveform at the output of IC7, it may be necessary to change the 56k resistors to 68k, and the 8k2 resistor to 10k. Also note that pin 1 and pin 16 of the CMOS hex inverter should go to +12 V and pin 8 to 0 V."

# Intruder alarm systems

**Every three minutes a home or business in Australia will be burgled this year. With statistics like this, it's not surprising that people from all walks of life are becoming more security conscious and are turning to intruder alarms to protect their property.**

The commercial consequence of this is that consumers are faced with a wide, and possibly confusing, array of equipment and services which may not give them enough information for their specific needs.

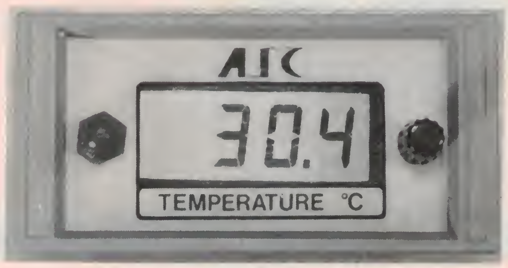
The Standards Association of Australia has just published a draft standard, DR 82022, on which it is seeking public comment, which provides guidance to the layman on the selection of intruder alarm systems in domestic and business applications. SAA believes that the availability of such a standard will improve general security because users will be better informed and capable of selecting an alarm system more suitable for their requirements.

The main feature of the proposed standard — a simple to understand publication to assist non-technical users — is the listing and explanation of the various alarm systems available, with details of the advantages and disadvantages of each type of system.

Technical terms have been kept as simple as possible, as it is intended that this proposed standard will be used by householders and business people who may have no technical background.

Attention is drawn to the fact that this is a draft only and is liable to alteration in the light of comment received.

Copies of DR 82022 can be obtained (free of charge) from any SAA office in all state capitals and Newcastle, and comment should be received before April 30 1982.




# Two new products from AIC

**Amalgamated Instrument Co recently increased its range of controllers and meters with a low-cost temperature controller and an mV-ph-temperature meter.**

Australian designed and manufactured, the panel temperature controller features digital display of process and setpoint, and has facilities for an additional alarm relay and a recorder output. The panel cutout size is only 45 x 92 mm, and the controller can be supplied to suit many other applications other than temperature.

The handheld mV-pH-temperature meter is also designed in Australia, and is said to be simple to operate, with such features as changing between functions by clicking the power switch. All switching is carried out electronically, and the meter retains the last function selected in its memory. It may be used as a digital thermometer or a selective ion meter, and has automatic temperature compensation for pH and an automatic low battery indicator.

For further information contact AIC Pty Ltd, Unit A, 59 Myoora Rd, Terrey Hills (P.O. Box 134, Terrey Hills) NSW 2084. (02)450-2661.

## Tough times for tantalums

**Tantalum pentoxide ($Ta_2O_5$), the base material for tantalum capacitor production, was in short supply during 1979/80, when it cost \$120-\$150/lb, but has recently slumped to under \$50/lb after a considerable slackening in demand following developments designed to reduce usage.**

Tantalum capacitor production accounted for around 45% of total world consumption of $Ta_2O_5$ last year. The 1979/80 shortage brought rapidly escalating prices for the material and the final product, and stimulated some technical and economic developments aimed at reducing usage of $Ta_2O_5$ in tantalum capacitors and producing alternative capacitor types.

The capacitance capability of tantalum powder was improved, reducing the quantity necessary for capacitor production, and developments in low-leakage, lower-cost aluminium electrolytic capacitors led to a reduced demand for tantalum types. Ceramic capacitors also found application in electronics where tantalums were previously specified, again wearing away at the market demand for tantalum.

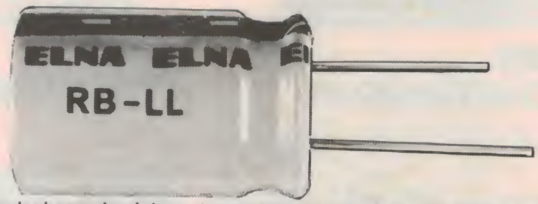
Japanese capacitor manufacturers reacted very sharply to the 'shock' 3½-fold increase in the price of tantalum powder during 1980. From 1976, production had grown at a rate between 22-33% a year. Electronic equipment manufacturers took steps to reduce the number of tantalum capacitors used, with the result that in the first four months of 1981 aluminium capacitor usage increased by some 30% over the same period the previous year, and ceramics by some 22%. Growth in tantalum usage at that time was a mere 0.05% (about 1.5%/year), where it had been 8% annually for the past decade.

Tantalum powder is also used in the aerospace and chemical industries and demand in these areas is expected to grow. If the video industry, currently falling short of growth targets, expands as expected, then demand for tantalum from the electronics manufacturers will increase beyond current levels as tantalum capacitors are heavily used in video equipment.

Despite the gloomy outlook, at least for the short term, mining companies are gearing up for increased production. Tantalum output from all sources world-wide was 1500 t in 1980 and is projected to be almost 2200 t by the year 2000. Primary sources such as the West Australian Greenbushes Tin mine and the Canadian Bernic Lake mine have commenced substantial expansion programmes. Other producers are gearing up to recover tantalum from the slag of old tin mines — principally in Brazil, Thailand and Malaysia.

Greenbushes Tin NL is reported to dominate future prospects as it holds a major deposit in West Australia expected to come on stream in 1983, producing a reported 68 t of $Ta_2O_5$ in its first year, rising to 340 t by 1986.

By 1985 Australia's total output of tantalite is expected to be twice that of the Bernic Lake mine, the largest producer at present. Tin slags, however, remain the world's largest single source of tantalum at the moment, accounting for some 40-50% of annual supplies.



The low-leakage aluminium electrolytic was developed to replace tantalums — but can only do so in some areas.

## Breadboards

**The Sydney-based firm of Emona has recently gained the agency for A-tek prototyping breadboards.**

These breadboards are just the thing for 'proofing' or experimenting with a circuit design. Components, including DIL ICs, just plug in, and interwiring is partly done by the breadboard and partly by using single-strand hookup wire between 20 and 29 AWG.

The A-tek breadboards are obtainable in terminal strip and distribution strip pieces which may be 'snap-locked' together, in a range of sizes from 100 to 1920 tie-points. Prices range from around \$2 to around \$40.

Details from Emona, CBC Bank Bldg, 661 George St, Haymarket Sydney. (02)212-4851.

## Applied Technology to concentrate on small buyer

**Applied Technology is already well-known for its range of Z80/S100 products, and recently purchased the remaining stocks of the 'Silicon Valley' chain to add to its status as a supplier of semiconductors to the small-scale buyer.**

Applied Technology began supplying this market in 1975 with its 'Electronic Mailbox', and is now promoting its Telephone Hotline service, which will operate from one outlet only in Hornsby. By thus centralising semiconductor supply it is much easier for AT to keep complete stocks and operate with lower prices.

Computer management of sales and ordering has also been installed, and the use of telephone/credit card facilities is expected to become extremely common, benefitting the customer with faster despatch times and no waiting for goods to come into stock.

For further information contact Phil Gleeson or Owen Hill on (02)487-3798.

## Flat pocket TV old hat

**No sooner had our October issue with the article on Clive Sinclair's flat pocket TV tube and receiver appeared in the newsagents than a reader, M. Chevallier of Killara NSW, appeared on our doorstep with a 1966 news item on the subject.**

What's more, the news item, from Popular Mechanics of April '66, was about a **colour** tube! It seems that a Los Angeles firm, Intertel Corp, had developed a flat colour picture tube with a 150 mm (6") screen and only 60 mm thick. They had a monochrome version, too. The man responsible was engineer Leo Shanafelt.

The operating principle was different to Sinclair's recent development. The colour tube had two faces — one with a red-orange phosphor and one with a blue-green phosphor. Deflection plates were deposited on the faces between the phosphor and the glass of the tube. The deflection plates on the red-orange phosphor face were transparent, and this formed the viewing face. Two electron guns were used, mounted at the bottom of the tube. Deflection was achieved by a magnetic yoke around the base of the tube. The electron beams were arranged to strike the appropriate phosphor as required. But, as only two phosphors were used, only limited colour was achieved.

Interesting. Many thanks to Mr. Chevallier for bringing the item to our attention.

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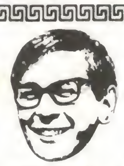

## ELECTRONIC TECHNICIANS

We require the services of several electronic technicians to work in our Service Department at North Ryde. The work involves repair of an enormous variety of electronic equipment in our air conditioned workshops. Applicants should ideally possess the E&C certificate, have had several years experience in the industry and be able to work without supervision. Salary negotiable and generous staff benefits apply. If you think that you're the person that we need, please apply in writing to:

Gary Crapp
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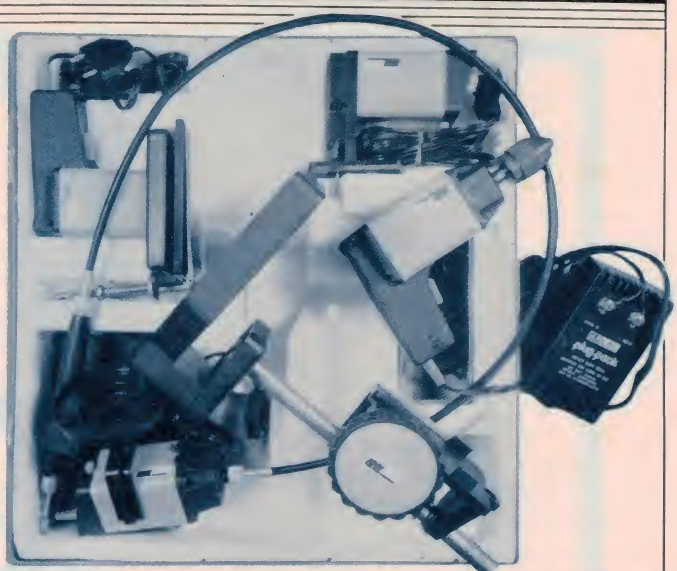


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### RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Minitool Australia, Murray Publishing, Offset Alpine, Australian Consolidated Press and/or associated companies.

Closing date for the contest is 31 May 1982. Entries received within seven days of that date will be accepted if postmarked prior to and including 31 May 1982.

The winning entries will be drawn by the Managing Editor of ETI, whose decision will be final. No correspondence can be entered into regarding the decision.

Winners will be advised by telegram the same day the result is declared. The name of the winners, together with the winning answers, will be published in the next possible issue of ETI.

Contestants must enter their names and address where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in states where local laws prohibit entries.

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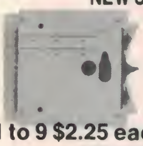

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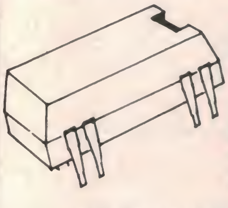

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# Power supplies and voltage regulators

In this first edition of our new Circuit File series, design consultant Ray Marston takes an in-depth look at practical power supply and voltage regulator circuits.

**Ray Marston**

TWO OF THE MOST common tasks facing the electronics designer or experimenter are those of designing basic power supply circuits to enable pieces of equipment to operate from ac power, and designing voltage regulator circuits to enable specific circuits to operate from well defined dc supply voltages over wide ranges of load current.

Both of these design tasks are reasonably simple. Basic power supply circuits consist of little more than a transformer-rectifier-filter combination, so all the designer has to do is select the circuit values, using a few very simple rules, to suit his own particular design requirements.

Voltage regulator circuits may vary from simple zener diode networks, designed to provide load currents up to only a few milliamps, to fixed voltage high current units for powering logic boards, etc, or to variable voltage high current units designed to act as general purpose pieces of test gear. We'll look at practical versions of all these examples in the next few pages.

## Power supply circuits

Basic power supply circuits are used to enable pieces of equipment to operate safely from ac mains power (rather than from batteries), and are simply designed to convert the ac mains voltage into an electrically isolated dc voltage of the value required by the actual circuitry of the equipment.

The basic power supply circuitry consists of little more than a transformer-rectifier-filter combination; the transformer is used to convert the ac line voltage into an electrically isolated and more useful ac value, and the rectifier-filter combination is used to convert the new ac voltage into the appropriate dc value.

Figures 1 to 4 show the four most useful transformer-rectifier-filter combinations you will ever need. The Figure 1 circuit provides a single-ended dc supply from a single-ended transformer and bridge rectifier combination, and gives a virtually identical performance to the centre-tapped transformer circuit of Figure 2. The circuits in Figures 3 and 4 both provide 'split' or 'dual' dc supplies and, again, give virtually identical performance. The rules for designing these circuits are very simple, as you'll see in a moment.

## Transformer-rectifier selection

The three most important parameters of a transformer are its *secondary voltage,* its *power rating,* and its *regulation factor.* The secondary voltage is always quoted in RMS terms at full rated power load, and the power load is quoted in terms of VA or watts (though VA is more widely used). Thus, a 15 V, 20 VA transformer will provide a secondary voltage of 15 V RMS when its output is loaded by 20 watts. When the load is removed (reduced to zero) the secondary voltage will rise by an amount specified by the *Regulation Factor.* Thus, the output of a 15 volt transformer with a 10% regulation factor (a typical value) will rise to 16.5 volts when the output is unloaded.

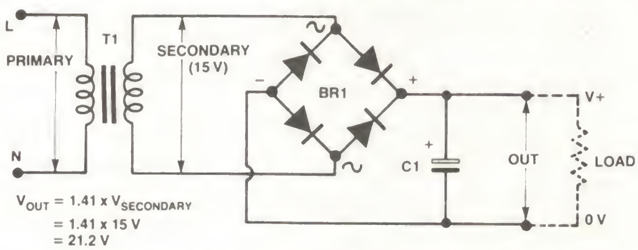



*Figure 1.* **Basic single-ended supply using a bridge rectifier module.**

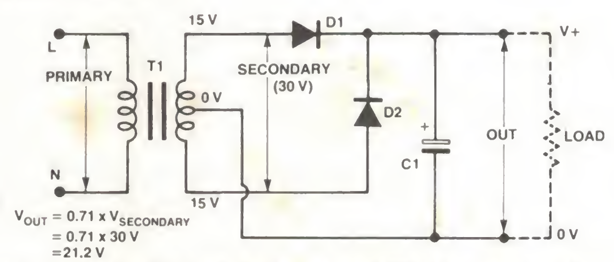



*Figure 2.* **Basic single-ended supply using a centre-tapped transformer.**

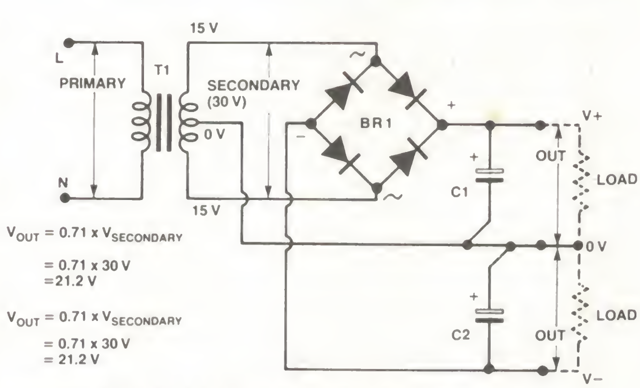



*Figure 3.* **Basic dual supply using a bridge rectifier module.**

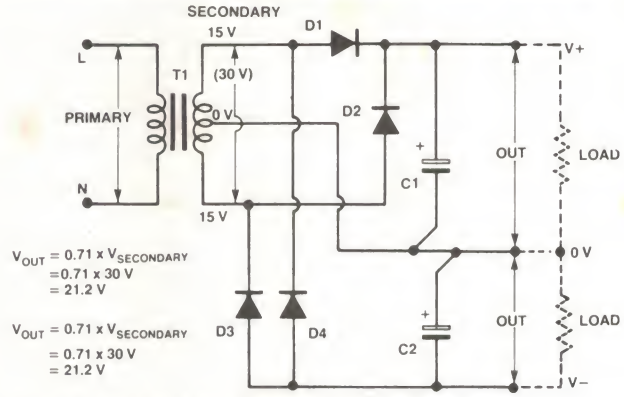



*Figure 4.* **Basic dual supply using individual diodes.**

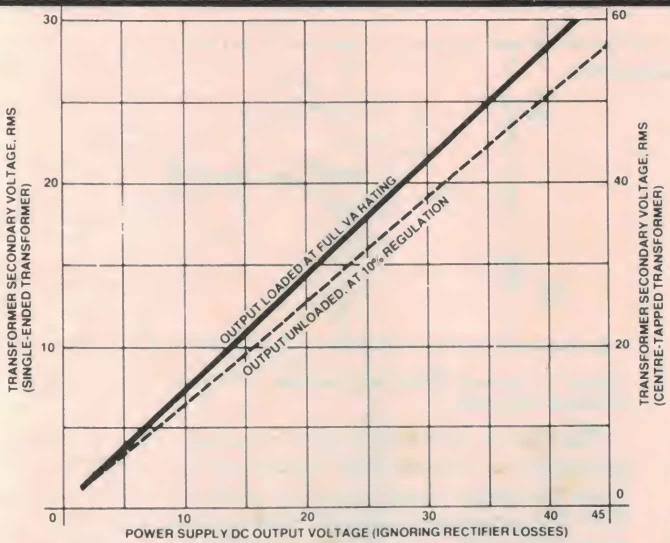



*Figure 5.* **Transformer selection chart (see text).**

Now, the most important point to notice here is that the RMS output voltage of the transformer secondary is *not* the same as the dc output voltage of the complete power supply. In fact, the dc output voltage of a fullwave rectified circuit is 1.41 (i.e: $\sqrt{2}$) times the RMS transformer voltage (ignoring rectifier losses) that is feeding the rectifier, as shown in the graph of Figure 5. Note here that this voltage is equal to 1.41 times the voltage of a single-ended transformer. Thus our single-ended 15 V RMS transformer with 10% regulation will in fact provide an output of about 21 volts at full rated load (just under 1 amp at a 20 VA rating) and 23.1 volts at zero load.

When rectifier losses are taken into account, the output voltages will be slightly lower than shown in the graph. In the 'two-rectifier' circuits of Figures 2 and 4, the losses amount to about 600 mV, while in the 'bridge' circuits of Figures 1 and 3 the losses amount to about 1.2 volts. The rectifiers should, for maximum safety, have continuous current ratings at least equal to the dc output currents, but preferably greater.

Thus the procedure for selecting a transformer for a particular problem is very simple. First, decide on the dc output voltage and current that are required; the product of these two values (allowing for slight rectifier losses) determines the minimum VA rating of the transformer. Next, consult the graph of Figure 5 to find the transformer secondary RMS voltage that corresponds to the required dc voltage. Simple?

## The filter capacitor

The purpose of the filter capacitor is to convert the fullwave rectified output of the rectifier — which consists of half-sinewave pulses — into a smooth dc output voltage. The two most important parameters of the capacitor are its *working voltage* and its *capacitance value*. The capacitance value determines the amount of ripple that will appear on the dc output voltage when current is being drawn from the circuit.

As a rule of thumb, in a fullwave rectified power supply operating from a 50 Hz power line, an output load current of 100 mA will cause a ripple waveform of about 700 mV peak-to-peak to be developed from a 1000u filter capacitor, the amount of ripple being directly proportional to the load current and inversely proportional to the capacitance value, as shown in the 'design guide' of Figure 6. In most practical applications, the ripple should be kept below 1-1.5 volts peak-to-peak under full load conditions. If very low ripple is required, the basic power supply can be used to drive a three-terminal voltage regulator, which can easily reduce the ripple by a factor of 60 dB or so at very low cost.

## Voltage regulator circuits

Voltage regulators may vary from simple zener-based circuits designed to provide load currents up to only a few milliamps, to fixed voltage high current circuits designed around 'fixed' three-terminal regulator ICs, or to variable voltage high current circuits designed around 'variable' three-terminal regulator ICs. We'll look at practical versions of all three types of circuit in the next couple of pages.

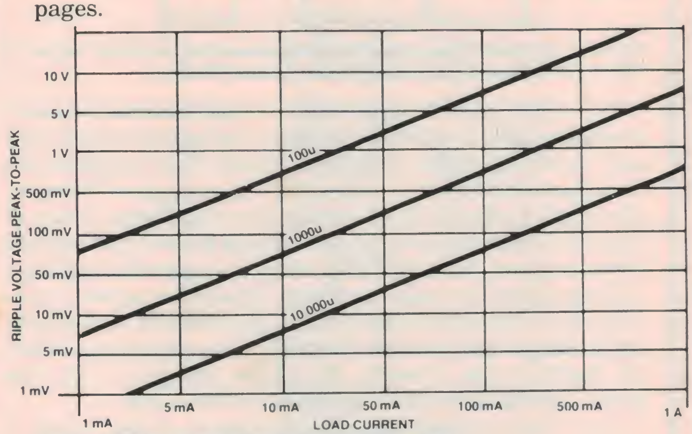



*Figure 6.* **Filter capacitor selection chart (see text).**

## Zener-based circuits

A zener diode can be used to produce a fixed reference voltage simply by using the connections shown in Figure 7. Here, a curent of roughly 5 mA is passed through the zener diode from the supply line via limiting resistor R. Often, the supply voltage ($V_{in}$) may be subject to fairly wide variations, causing the zener current to vary over a similarly large range. So long as $V_{in}$ is always more than a few volts greater than the zener voltage and provided that the zener power rating is not exceeded, this variation has only a moderate influence on the output voltage of the zener, which typically has an effective output impedance of only a few tens of ohms.

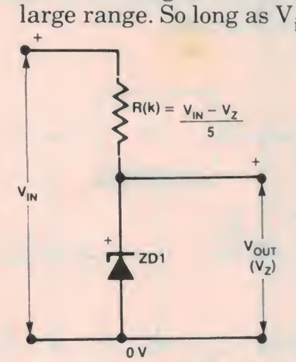



*Figure 7.* **Basic zener reference circuit. Bias is about 5 mA.**

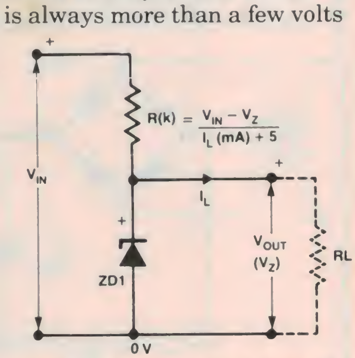



*Figure 8.* **Zener reg. can supply load currents up to a few tens of mA.**

A zener can be used as a very simple voltage regulator, providing maximum load currents up to a few tens of milliamps, by merely selecting the value of 'R' as shown in Figure 8. Here, when the designed maximum load current is being drawn only 5 mA flows through the zener; when zero load current is being drawn the zener passes 5 mA plus the maximum designed load current, and thus dissipates maximum power. It is important to ensure that the power rating of the zener is not exceeded under this 'no load' condition. ▶

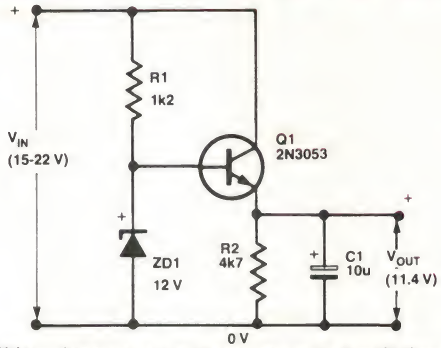



*Figure 9.* **This series-pass, zener-based regulator circuit gives an output of 11.4 V and can supply load currents up to about 100 mA.**

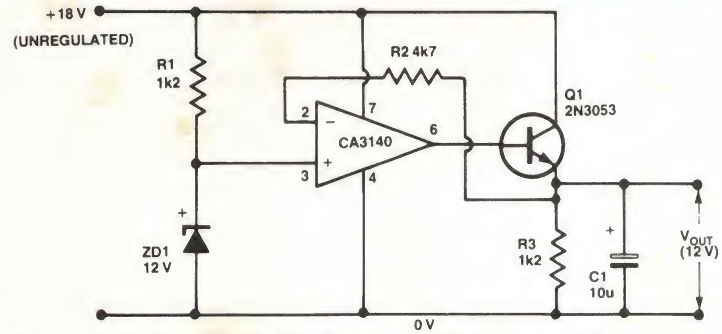



*Figure 10.* **Op-amp based reg. provides 12 V at up to 100 mA with excellent regulation.**

In most practical voltage regulator applications the zener is simply used to apply a 'reference' voltage to a high gain non-inverting buffer amplifier, which then supplies the required output power. The simplest example of this type of circuit is shown in the series-pass regulator circuit of Figure 9. Here, Q1 is wired as a voltage follower, its emitter remaining at about 600 mV below its zener-defined base voltage under all load conditions. The zener network provides the base drive current to Q1, this current being equal to the output load current divided by the current gain of the Q1 'buffer' stage. Clearly, the higher the gain of Q1, the better will be the output regulation of the circuit.

One way of improving the regulation of the Figure 9 circuit would be to use a Darlington or super-alpha pair of transistors in place of Q1. An even better solution is to use the op-amp plus transistor buffer stage shown in Figure 10. Here, the op-amp and Q1 are wired as a unity gain non-inverting dc amplifier with a near-infinite input impedance and near-zero output impedance. The output voltage tracks within a few mV of the zener reference value. The safe output current is limited to about 100 mA by the power rating of Q1; higher currents can be obtained if Q1 is replaced with a power Darlington transistor.

The Figure 10 circuit is very versatile. It can be made to generate any desired fixed voltage up to about 30 V maximum by simply using a suitable zener value and ensuring that the unregulated supply voltage is at least five volts greater than the zener value (up to 36 volts maximum). The circuit can be used as a variable voltage supply by simply wiring a potentiometer across the zener, with its slider taken to the non-inverting input of the 3140 op-amp; this op-amp can accept inputs all the way down to zero volts, enabling (for example) a 0-25 V supply to be easily implemented.

## Fixed three regulator circuits

Fixed voltage regulator design has been greatly simplified in the last decade by the introduction of three-terminal regulator ICs such as the '78xx' series of positive regulators and the '79xx' series of negative regulators. These ICs incorporate features such as built-in foldback current limiting and thermal protection. A wide range of three-terminal fixed voltage regulator ICs is available; standard current ratings are 100 mA, 500 mA, 1 A, and 3 A, and standard output voltage ranges are 5 V, 6 V, 8 V, 12 V, 15 V, 18 V and 24 V.

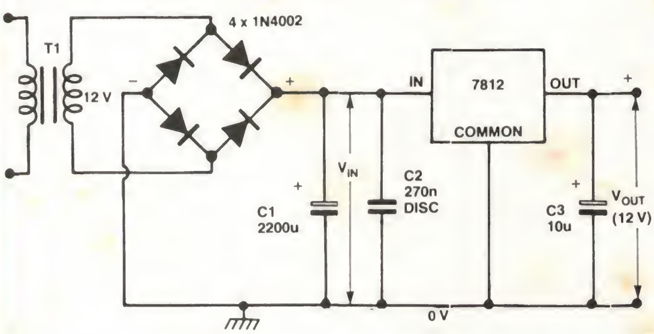



*Figure 11.* **Circuit employing a common three-terminal positive regulator.**

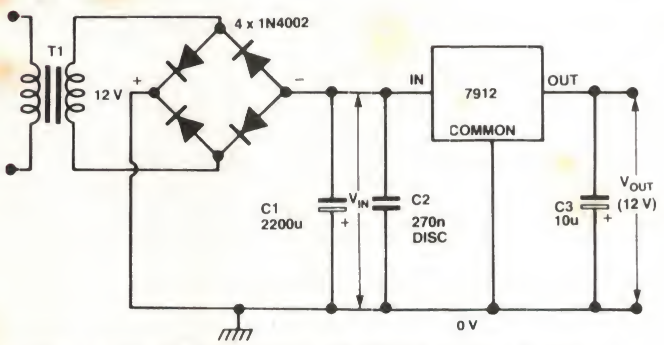
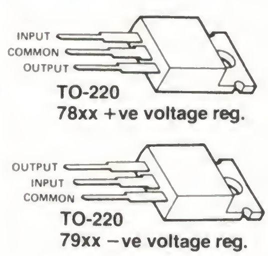



*Figure 12.* **Circuit using a common three-terminal negative regulator.**



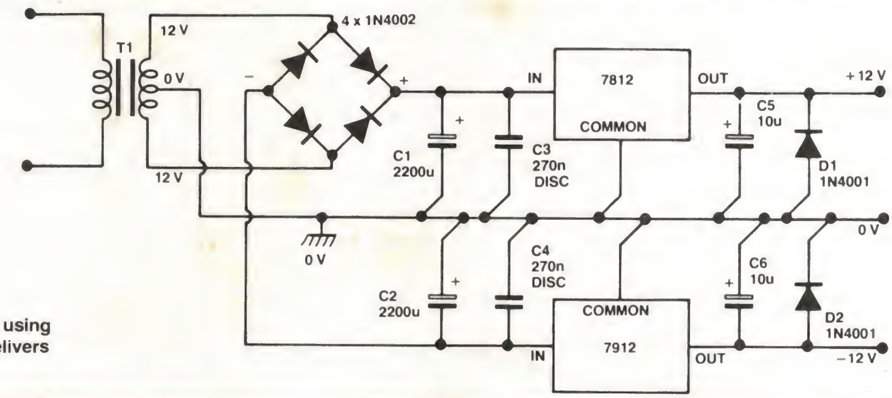




*Figure 13.* **Complete circuit of a dual supply using three-terminal regulators. This supply delivers +/− 12 V at up to 1 A.**

Three-terminal regulators are remarkably easy to use, as shown in the basic circuits of Figures 11 to 13, which show the connections for making positive, negative and dual regulator circuits respectively. The ICs shown in these examples are 12 volt units with current ratings of 1 A, but the basic circuits are valid for all other voltage ratings, provided that the unregulated input voltage is at least three volts greater than the desired output voltage.

If the connection between the regulator's input and the rectifier's filter capacitor is more than 50 mm in length, then a capacitor is needed across the regulator's input terminals to maintain stability. Generally, all that is necessary is a 200n or greater value disc or plate ceramic capacitor, mounted right at the regulator's terminals using short leads. Alternatively a 2u2 or larger value tantalum could be used. You often see a capacitor connected across the regulator's output, too. Although not always necessary, a capacitor in this position reduces high frequency noise and improves transient response. A 100n or greater ceramic capacitor is recommended, or an electrolytic of 1u to 10u or so.

The output voltage of a three-terminal regulator is referenced to the 'common' terminal of the IC, which is normally (but not necessarily) grounded; most regulator ICs draw quiescent currents of only a few mA, which flow to ground via this 'common' terminal. The regulator output voltage can thus easily be raised above the designed value by simply biasing the 'common' terminal with a suitable voltage, making it easy to obtain 'odd-ball' output voltages from the regulator. Figures 14 to 16 show three ways of achieving this.

In figure 14 the bias voltage is obtained by passing the IC's quiescent current (typically about 8 mA) through RV1. This design is adequate in most applications, although the output voltage obviously shifts slightly with changes in quiescent current. The effects of such changes can be minimised by using the circuit of Figure 15, in which the RV1 bias voltage is determined by the sum of the quiescent current and the bias current set by R1 (12 mA in this example). If a fixed output voltage is required other than the designed value, it can be obtained by wiring a zener diode in series with the common terminal, as shown in Figure 16, the output voltage then being equal to the sum of the zener and regulator voltages.

The output current capability of a three-terminal regulator can be increased by using the circuit of Figure 17. Resistor R1 is wired in series with the regulator IC. At low currents, insufficient voltage is developed across R1 to turn Q1 on, so all the load current is provided by the IC. At currents of 600 mA or greater sufficient voltage (600 mV) is developed across R1 to turn Q1 on, so Q1 provides all currents in excess of 600 mA.

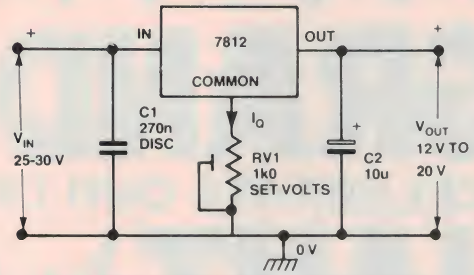



*Figure 14.* **Simple method to vary output voltage.**

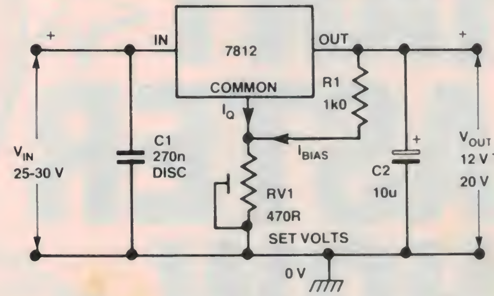



*Figure 15.* **Improved method of varying output voltage.**

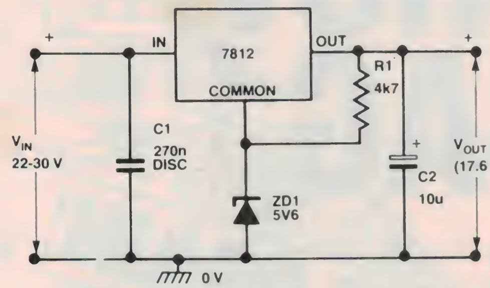



*Figure 16.* **'Jacking up' the output voltage using a zener.**

Finally, Figure 18 shows how the bypass transistor of the above circuit can be provided with overload current limiting via an 0R12 current-sensing resistor (R2) and turn-off transistor, Q2.

## Variable three-terminal regulator circuits

We've already seen that the outputs of '78xx' regulators can be varied over limited ranges by simply applying suitable variable voltages to their common or reference terminals, even though these ICs are designed as fixed regulators. If, however, you need to vary the output voltages over fairly wide ranges, a far better solution is to use one of the special variable three-terminal regulator ICs, such as the 317K or the 338K. ▶

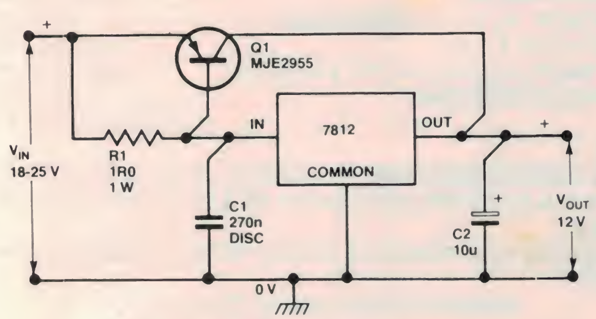



*Figure 17.* **Increasing the output current capacity of a three-terminal regulator. This will deliver 5 A at 12 V.**

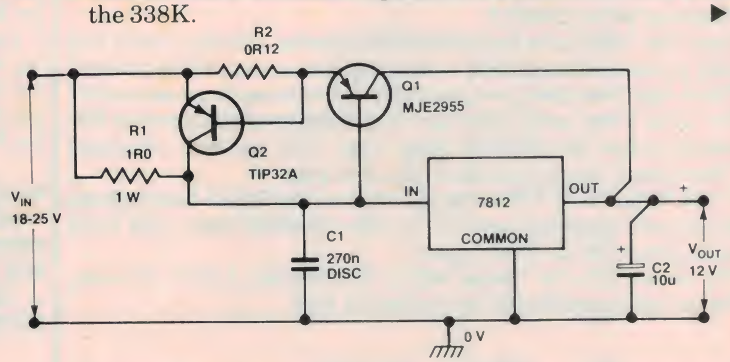



*Figure 18.* **Providing overload protection for the Figure 17 circuit. Q2 'robs' Q1 of base current when load current goes above 5 A.**

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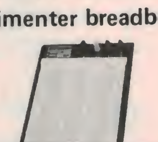

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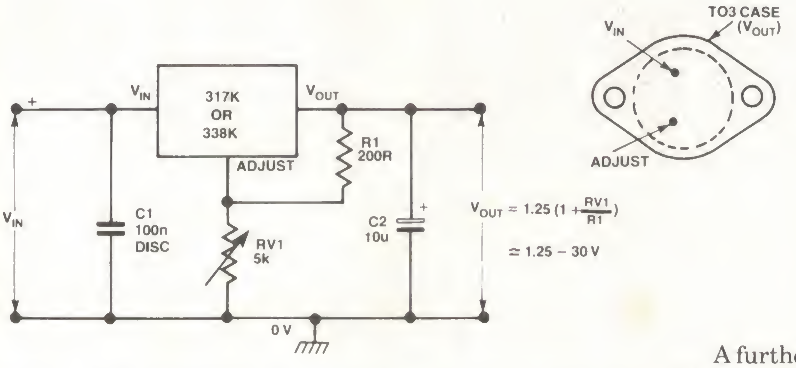


| PARAMETER | 317K | 338K |
|---|---|---|
| INPUT VOLTAGE RANGE | 4-40 V | 4-40 V |
| OUTPUT VOLTAGE RANGE | 1.25-37 V | 1.25-32 V |
| OUTPUT CURRENT RANGE | 1.5 A | 5 A |
| LINE REGULATION | 0.02% | 0.02% |
| LOAD REGULATION | 0.1% | 0.1% |
| RIPPLE REJECTION | 65 dB | 60 dB |

*Figure 19.* **Case outline, basic data and basic application circuit of the 317K and 338K variable-voltage three-terminal regulators.**

Figure 19 shows the outline, basic data and the basic variable-regulator circuit that is applicable to these two devices. Both devices have built-in foldback current limiting and thermal protection and are housed in TO3 packages, the major difference between the devices being that the 317K has a 1.5 amp current rating compared to the 5 A rating of the 338K. The major feature of both devices is that their 'output' terminals are always 1.25 volts above their 'adjust' terminals, and their quiescent or adjust-terminal currents are a mere 50 uA or so.

Thus in the Figure 19 circuit, the 1.25 volt difference between the 'adjust' and 'output' terminals causes several mA to flow to ground via RV1, thereby causing a variable 'adjust' voltage to be developed across RV1 and applied to the 'adjust' terminal. In practice, the output of the Figure 19 circuit can be varied over the approximate range 1.25 to 30 volts via RV1, provided that the unregulated input voltage is at least 3 V greater than the maximum output voltage. Naturally, alternative voltage ranges can be obtained by giving R1 and/or RV1 alternative values, but it should be noted that for best stability the R1 current must be at least 3.5 mA.

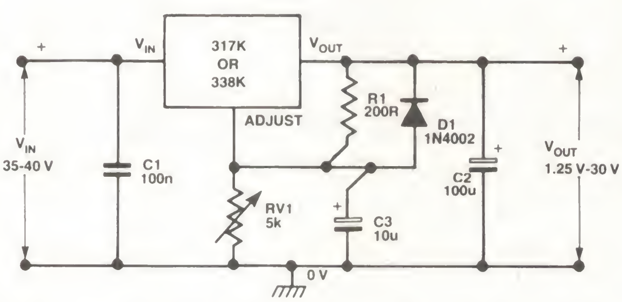


*Figure 20.* **This version of the variable-voltage regulator provides some 80 dB of ripple rejection.**

The basic Figure 19 circuit can be usefully modified in a number of ways. The basic ripple rejection factor of the Figure 19 circuit, for example, is about 65 dB, but this can be increased to 80 dB by wiring a 10u bypass capacitor across RV1, as shown in Figure 20, together with a protection diode connected as indicated, to prevent the capacitor discharging into the IC if the regulator output is short-circuited.

A further modification of the Figure 20 circuit is shown in Figure 21. Here, the transient output impedance of the regulator is reduced by increasing the C2 value to 100u; diode D2 is used to protect the IC against damage from the stored energy of this capacitor if an input short occurs.

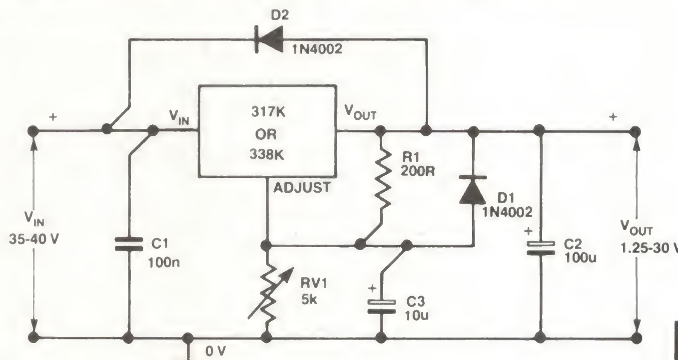


*Figure 21.* **This version has 80 dB ripple rejection, a low impedance transient response and full input and output short circuit protection.**

The minimum output voltage of the Figure 19 to 21 circuits is 1.25 volts. If you want the voltage to vary all the way down to zero, the circuits must be configured so that the adjust terminal goes to −1.25 V when RV1 is reduced to zero ohms. Figure 22 shows how this can be achieved, using a 35 V negative rail and a pair of series-connected diodes to clamp the low end of RV1 to −1.25 V.

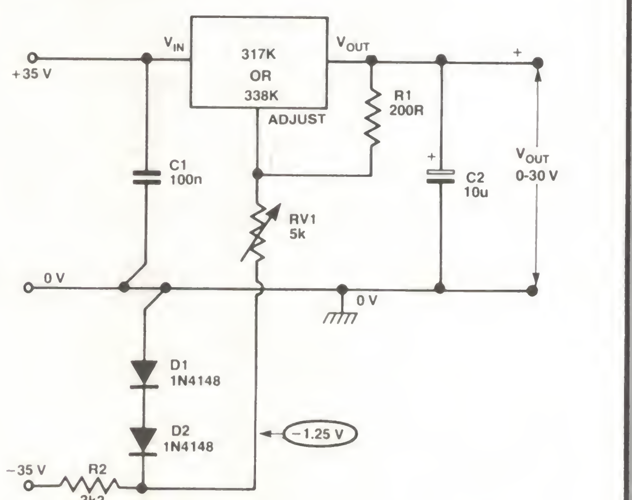


*Figure 22.* **How to provide variable output that goes from 0 V to 30 V.**

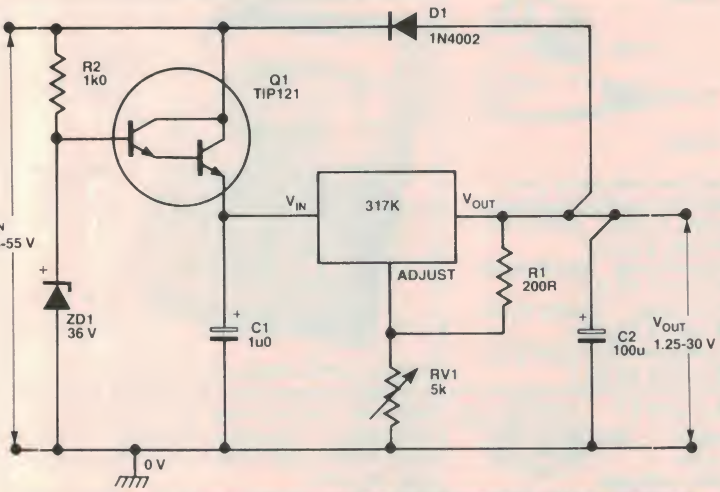


*Figure 23.* **This variable voltage unit uses a pre-regulator (Q1) to give input over-voltage protection and improved ripple rejection.**

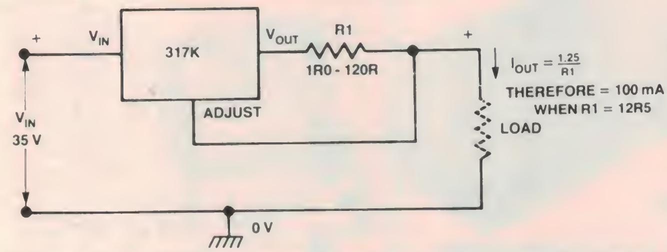


*Figure 24.* **A method of using the 317K as a precision current limiter or constant current generator.**

If you want to get the maximum possible voltage out of one of these regulators, you'll need to make sure that the input voltage does not exceed the 40 V rating of the IC. The best way to do this is to use a simple Darlington-plus-zener pre-regulator circuit, as shown in Figure 23, which enables you to use any unregulated input in the range 35 to 55 volts. Note that as well as giving input over-voltage protection, this pre-regulator also gives a further improvement in ripple rejection. If you want to use this circuit with a 5 A 338K regulator, you may need to reduce the value of R1 and beef up the power rating of the zener diode.

Finally, to complete this look at regulator circuits, Figure 24 shows how you can use the 317K as a precision current limiter or constant current generator in which the output current is determined by R1 and is virtually independent of the external load values. By suitable choice of R1, the constant-current magnitude can be set at any value between approximately 10 mA (R1 = 120R) and 1.25 A (R1 = 1R). Not bad for a two-component circuit! ●

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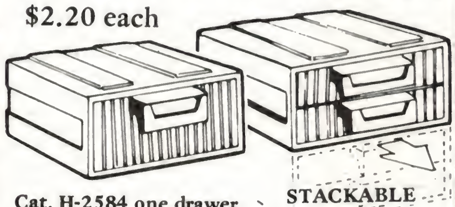


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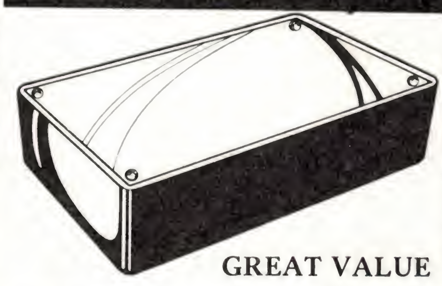

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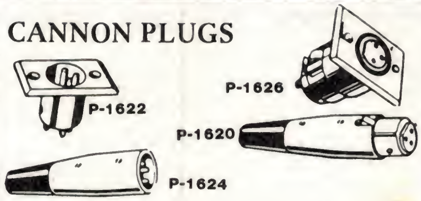


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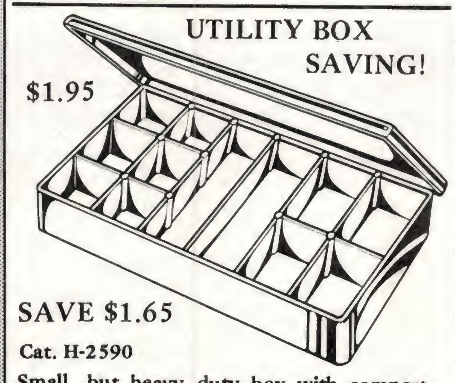

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# How to get into robotics without boiling your brain cells or breaking the bank Part 1

Without doubt, every electronics enthusiast has been fascinated with robots and robotics at some time or other. Here's an opportunity to build a robot that starts out as a simple, yet versatile, 'beast' with the capability of considerable expansion. This project is a 'minimum' kit version of the 'Tasman Turtle' robot from Flexible Systems, previously only available in built-up form, developed for publication by co-operation between ETI and Flexible Systems.

**Allan Branch**
Flexible Systems, Hobart, Tasmania

SOME PEOPLE like to watch turtles in glass tanks, others like to build them; this article is for the latter. Until now anyone wanting to participate in the fine art of robotics has had a number of problems to overcome before the opportunity to actually use a robot becomes a reality.

First of all you had to wait till the second half of the 20th century, when the combination of advanced computing and microelectronics finally brought robots to reality. The concept of an intelligent, moving machine, however, is far from that young; mechanical systems (though not intelligent) in the form of moving statues have been around since as long ago as 1500 BC, and in 1917 Karel Capek invented the title for the new form — he meant it to symbolise work, and the word 'robot' actually comes from the Czech *robota*, meaning forced labour.

The real 'day of creation' for 'intelligent' robots came in 1938, however, when Thomas Ross developed a robot mouse. This first robotic device could attempt and solve mazes, and led the way to descendants which still attempt (though not necessarily solve) mazes in appropriately named 'micro mouse' competitions around the world. After this, development seemed to go off down something of a blind alley, with a rather rigid obsession with microtechniques leading to the evolution simply of smaller and smaller mechanical dolls.

However, by 1968 we were on the right track, and finally saw the evolution of the 'true' robot, able to bump and trip up intelligently, albeit shakily.

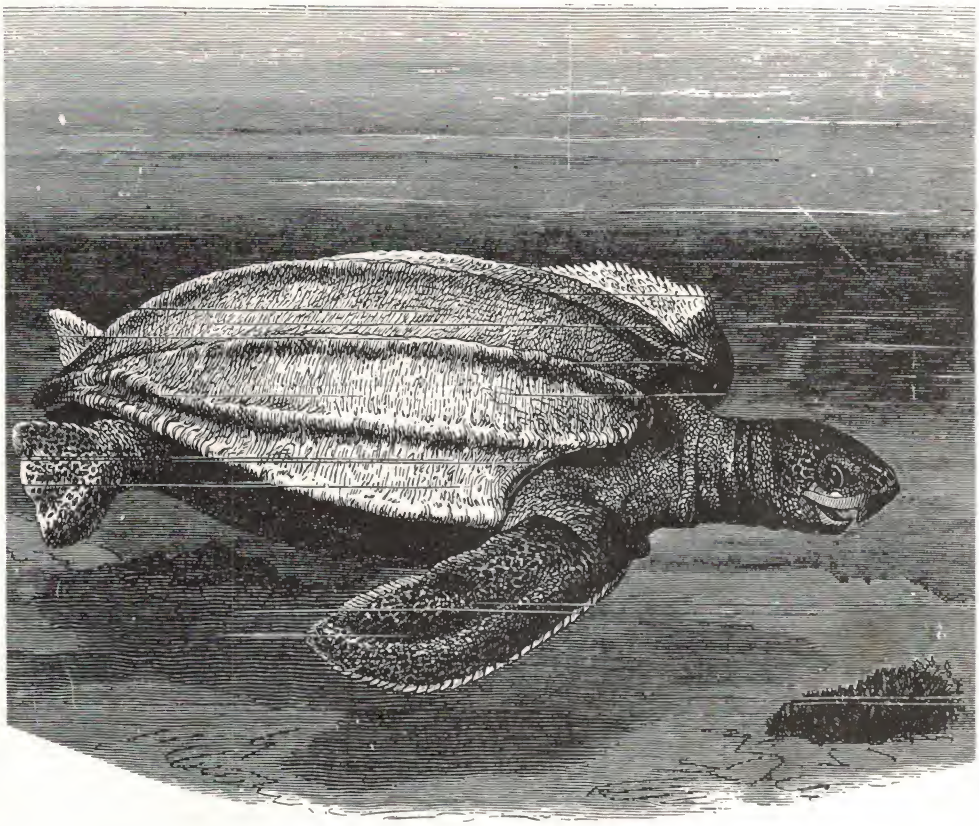
These developments didn't solve the robotics enthusiast's second problem, however, which was being able to combine masses of accumulated junk (the usual layman's term for assortments of electronic components and hardware) in order to create a complex *electronism* (analogous to an organism) that actually worked.

This proved a much harder step for most people than being born at the right time.

Consequently, most people interested in the concept but unable to put it into practice turned to the closely allied area of computing. They learnt to program computers in BASIC or machine code, to play mazes on monitors instead of with robots, and to come close to real robots only in screen simulations. It was a bit of a let-down, but we kept on expanding our make-believe (paper robots?) world with such gadgets as printers or disk drives in the hope of satisfaction.

Now, finally, robotics can become a reality. Someone else has put together the loads of components and hardware for us, and, just like the icing on the cake, has designed it to work from our computer and in the languages we have already learnt to use. Voila! The age of the Turtle is with us.

The evolutionary progress from semi-bright mice to intelligent turtles is quite a step, and who knows what will come next. In the meantime, though, what do you do with it?



## What is a Turtle, then?

The Tasman Turtle robot, when programmed accordingly, can be used for an almost unlimited range of projects and experiments. Even interaction with its environment is possible with its sense of 'touch', which feeds information back to the computer. A cable or remote control (radio, infrared or whatever) is used to connect the turtle to the computer, with the effect that the robot has the 'brains' of a large or small computer, but the compactness of a mobile base. If you were to try to put the computer on board your robot, it would have to have some pretty hefty motors in it and would have considerable current drain. Just think of the size of your 5 V power supply; the robot would have to have that too!

The Turtle is therefore a very versatile method of implementing a robot base without the problems of large batteries and large motors. As well as being able to 'feel' its way around (provided that's what you program it to do) the Turtle has a number of other functions. Two high-quality stepper motors are used for moving the base. These are geared to give approximately one millimetre of linear displacement per stepper motor pulse. To actually be able to position the robot to within a millimetre of where you want it is incredibly accurate, but this is possible with the Tasman Turtle. Each motor can be turned clockwise, anticlockwise or stopped, both independently, and their speed can be altered (again independently if need be). As a spin-off, you are going to know a fair bit about stepper motors, and how to control them, by the time the robot is completed.

Also standard with the Turtle robot are a two-tone horn, a pair of beautiful green eyes and an automatic pen holder. The Turtle circuit board has an auxiliary driver channel, allowing you to run additional custom-designed equipment. This means that without having to worry about further electronics or extra control lines from the computer, you can connect your own relay or solenoid, or whatever, from the start. The auxiliary driver utilises the same line as the horn 'high' tone, so if you decide to add your own equipment, the horn becomes single-tone.

All sorts of communication can be carried out using the Turtle's horn or its eyes. The eyes, for example, can be programmed to flash once for yes or twice for no. You could devise a code so that when your program needs information (suppose your turtle is trapped in a maze and wants to know which way to turn to get out) then different numbers of flashes mean different codes. (In the case of the maze you could respond by touching one of the switches and having the turtle move in that direction).

Similarly the horn can be used for communication since it can be pulse-coded (high = on, low = off). Why not try learning Morse code by having the Turtle talk to you in Morse code with its horn? Different sound effects are possible by varying the tone and the timing of the horn control.

The last thing the Turtle has is its automatic pen mechanism, designed to hold any normal thin pen, pencil or felt pen, which can be controlled (up or down) from the computer. The Turtle becomes a ready-made graphics device with the 'pen in toe' and, combined with the accuracy mentioned previously, the computer art capabilities are enormous. Some ideas worth mentioning are to get the Turtle to spell your (or its!) name — try it in script writing. Get it to print questions or statements on paper instead of on the screen. It could leave a path when it follows a maze to give a permanent trace of its movements. What about using it as an xy plotter? Quite complex patterns or designs are simple to generate using the pen facility. I have even had the Turtle 'rattle its brains' by vibrating the solenoid for a startling effect (without the pen in its holder!).

*NOTE: 'Tasman Turtle' is a registered trade mark of Flexible Systems.*

The next thing to learn is how to actually make the Turtle do all these things. Firstly, though, it is important to contemplate a few aspects of the robot so that you can enjoy all its benefits.

This Tasman Turtle is probably the first robot for hobbyists designed to be run from a microcomputer, and as such is perhaps much more powerful than anything seen before. It is certainly more versatile. The programming (as will be explained) is extremely easy, so much so that even a complete novice will be able to run the Turtle around long before screen graphics are mastered. The sample programs to be given are in BASIC, but the Turtle can run in any language, even machine code, and a very special language called LOGO has been developed so that the Turtle can be programmed by typing in words like 'forward, back, left, right, pen up, toot 10', etc.

A big feature of the Tasman Turtle is its versatility. Because it is not restricted to ROMs (and therefore to people who can handle ROMs) there is no special equipment or requirements needed to get started. You can make the Turtle do simple things to begin with and then progress as you become better at programming or as you become more familiar with the robot. It is possible to do quite advanced experiments with the Turtle which require no actual changes to the robot. It is all possible because the robot takes on the identity of *your* program. It can be an art robot; be used to devise heuristic programs, study learning techniques, simulate conditioning; it can study the shape of a room and build a memory map or identify objects, detect objects that have changed position, work out the area and perimeter of

the room; it could take on promotional work, have fun in shop windows, advertising; demonstrate information theory, process control and many other things I haven't even thought of. Most of all, though, it is *fun* robotics.

While the Tasman Turtle is multivariate by virtue of programmability, it is also a suitable standard base for anyone interested in further electronic add-ons. Most of us have some ideas of what we would have in a robot if we built one, and the Turtle robot becomes a platform for just that.

A wide range of simple and effective projects can be implemented with the Turtle, from line following to speech, and some will be presented in this short series of articles. Many projects meant for other uses will also adapt easily to the Turtle (anemometer, light sensor, load detector, sound operated switch, for example), and I can just see little claws 'snapping' away at anything that crawls! Imagine — a moving, talking, hooting-tooting, snapping Turtle!

Enough day-dreaming, shall we get on with the reality?

## PARTS LIST ETI-645

### MINIMUM TURTLE — HARDWARE

- 1 x bakelite base, 330 mm dia., cut and drilled
- 2 x front motor mounts (triangular)
- 2 x rear motor mounts (elbows)
- 2 x wheel axle brackets (small elbows)
- 2 x stepper motors
- 2 x small brass gears, 12 mm dia.
- 2 x nylon gears, 40 mm dia.
- 2 x axles (5 x 45 mm)
- 2 x rubber tyred wheels
- 4 x microswitches
- 1 x wooden front foot (hemispherical, drilled)
- 1 x smoke-tinted plastic dome
- 1 x circular 'touch' band
- 1 x clear plastic disc, 230 mm dia., drilled
- 1 x small speaker
- 1 x solenoid
- 1 x pen bracket & clamp assembly
- 4 x red LEDs and bezels
- 2 x green bezel lamps
- 1 x 100R, 1 W resistor
- 1 x 1 m length rainbow cable
- 1 x length of speaker wire
- 1 x 25-pin connector (RS232 type)
- 2 x hex keys (for gear grub screws)
- 4 x 1" x ⅛" Whitworth steel screws
- 4 x ¾" x ⅛" Whitworth steel screws
- 13 x ¼" x ⅛" Whitworth steel screws
- 2 x ½" x ⅛" Whitworth steel screws
- 2 x ⅜" x ⅛" Whitworth steel screws
- 24 x ⅛" Whitworth steel nuts
- 43 x metal washers
- 1 x metal self-tapping screw
- 4 x ½" (12.5 mm) long x ⅛" tapped Whitworth metal spacers
- 2 x ½" (12.5 mm) long tubular spacers
- 2 x 2" (50 mm) long tubular spacers
- 2 x 2½" (63.5 mm) long tubular spacers
- 4 x 3" long x ⅛" Whitworth steel screws

## Construction

There are four individual sub-assemblies involved in the 'minimum' Turtle. These are: the base, the small inner disc, the electronic control pc board and the dome. Everything mounts to the base, one way or another. Putting the beast together is simpler than describing it — of that, we can assure you! In this part we will cover the assembly of motor drive and 'touch' systems to the base plus the assembly of the various components that mount on the small inner disc. In the next part (May issue) we will cover the assembly of the electronics and completing the Turtle, plus a power supply and rudimentary controller. Let's go, then!

First step is to sort out and identify all your hardware. A hardware parts list is included here for your guidance. Note that, where possible, measurements have been given in metric and imperial. Generally, Whitworth thread nuts and bolts are employed. You will need some 'five minute' epoxy glue, or similar.

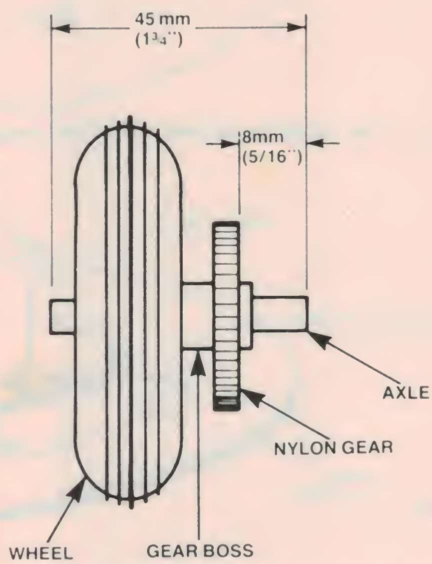



*Figure 1.* **Wheel assembly. Wheel hub butts against gear boss and the two are glued at this point.**

## Wheels

Figure 1 shows the wheel assembly when completed. Place a nylon gear on each axle such that the face opposite the boss is exactly 5/16" (8 mm) from one end. Tighten the grub screw using the appropriate hex key supplied (the larger of the two). Now push a rubber tyred wheel on each axle — you'll find it a firm fit, so that the wheel and gear boss touch. Glue the wheel to the gear boss using epoxy glue or similar. ▶

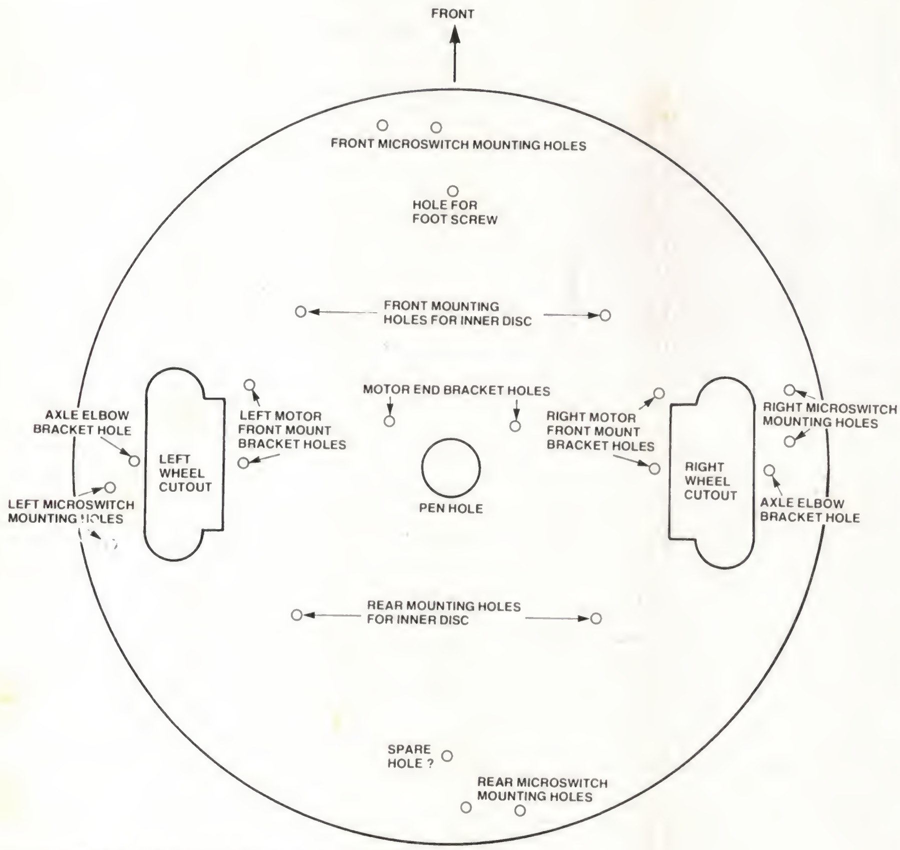



*Figure 2.* **The Turtle base and how to identify the various holes.**

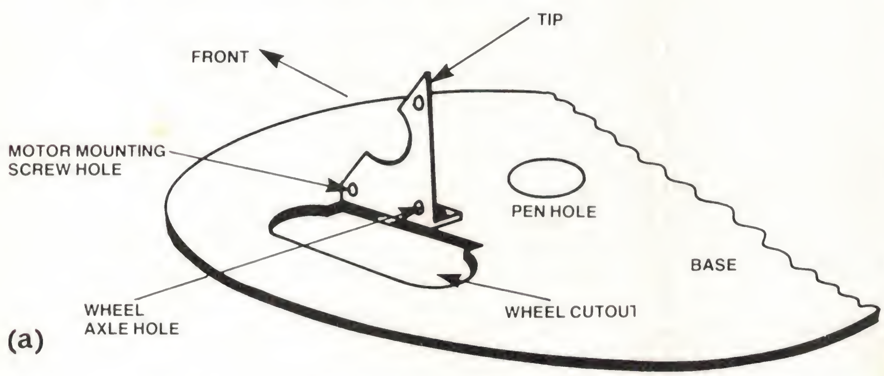
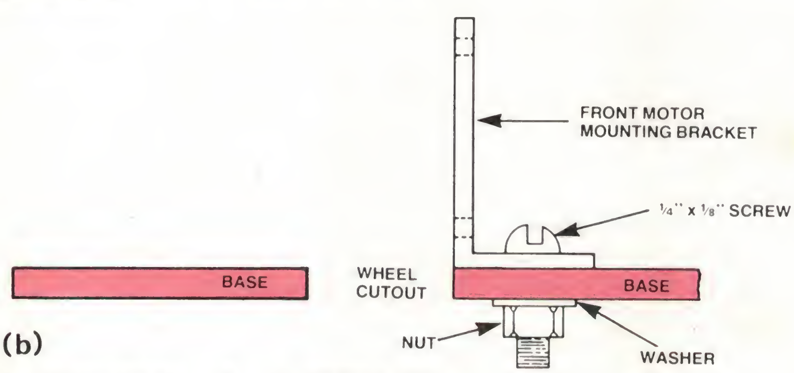



*Figure 3.* **(a) Mounting the left hand front motor bracket to the base. (b) Position the bracket such that the edge is flush, or as near as possible, with the edge of the wheel cutout. The right hand bracket mounts in a similar way.**






**Motor and wheel assembly mounting brackets. From left to right: rear motor elbow bracket, small elbow wheel axle bracket and the front motor mounting bracket. You'll have a pair of each.**

## Base

Take the bakelite base and identify the top — you should find a 'Made in Tasmania' sticker on the top side. If not, turn it so that the holes correspond with Figure 2. Identify the two front motor mount brackets.

Now find out which is for the left hand motor and which is for the right. Taking the left hand bracket, mount it as shown in Figure 3a. Ensure that the bracket is flush with the edge of the wheel cutout (or nearly so), as in Figure 3b. The right hand bracket is mounted in a similar fashion.

Now you can mount the wheels. Locate the wheel axle hole in the left hand motor bracket — see Figure 3a. Take one wheel assembly. The nylon gear goes toward the motor mount bracket. Slip that end of the axle in the appropriate hole in the bracket (Figure 4a), slip a small elbow wheel axle bracket on the other end of the axle and secure it as shown in Figure 4b. Note that the slotted hole in the small elbow axle bracket is on the base and the bolt passes through it. Now mount the other wheel in a similar fashion.

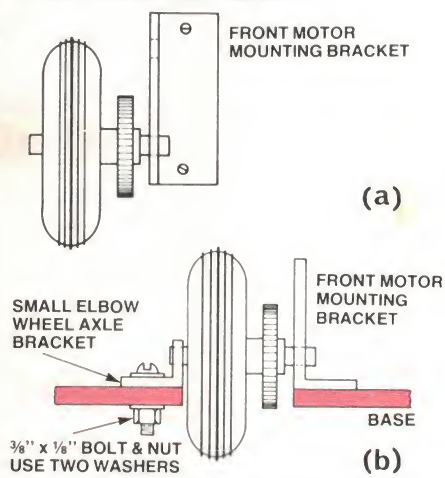



*Figure 4.* **Mounting the wheel assembly to the left hand front motor bracket. (a) Insert the nylon gear end of the axle in the appropriate hole in the front motor bracket (view looking down). (b) Support the other end of the axle with the small axle elbow bracket and temporarily bolt it in place. The right hand wheel assembly mounts in a similar way.**

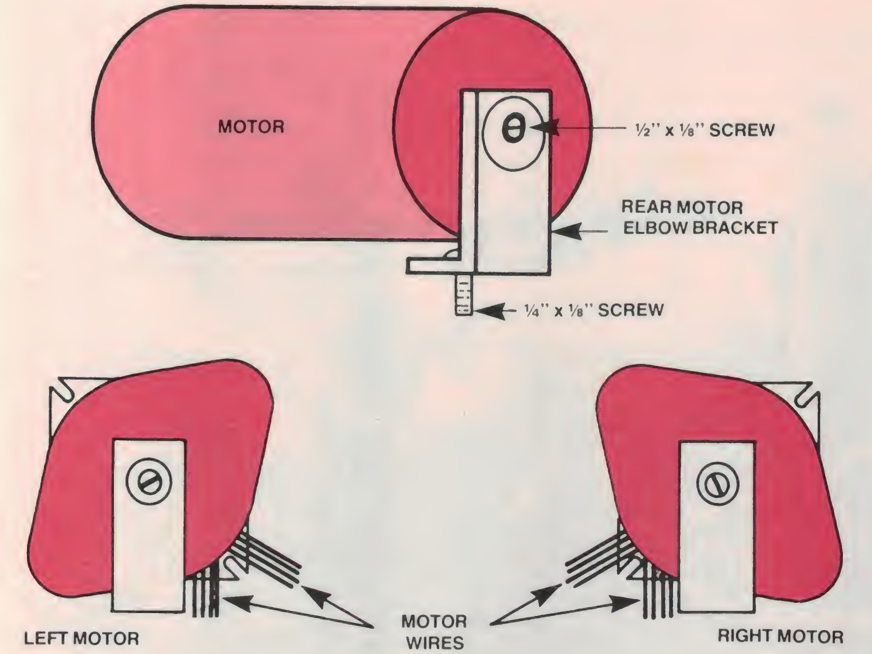



*Figure 5.* **How the rear motor mount bracket is fixed to each motor. Note the different positions for the left and right motors.**

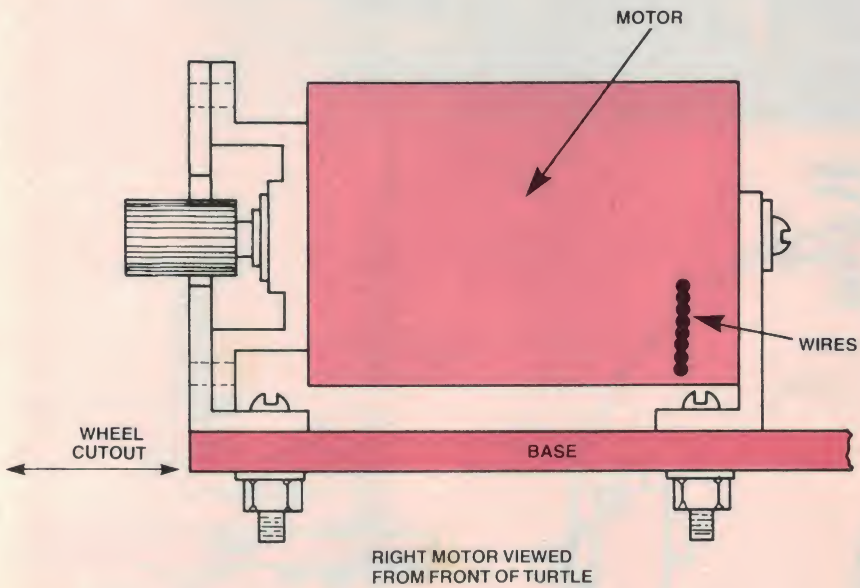



*Figure 6.* **Mounting the motor. Secure the end bracket screw first.**

The front 'foot' comes next. This is a small hemisphere of wood with a hole drilled in the bottom. Locate the mounting hole for it — see Figure 2 — and secure it to the underside of the base with the self tapping screw provided. Take care not to tighten it too much or your might split it.

**The wooden front 'foot' and its mounting screw.**

## Motors

Take the two stepper motors and the two small (12 mm dia.) brass gears. These should be placed on each motor shaft so that the grub screw is furthest from the motor. Mount each gear flush

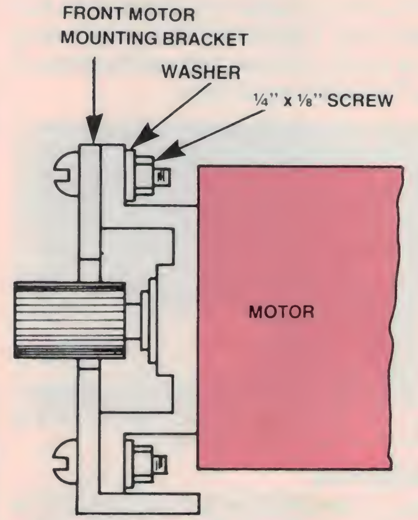
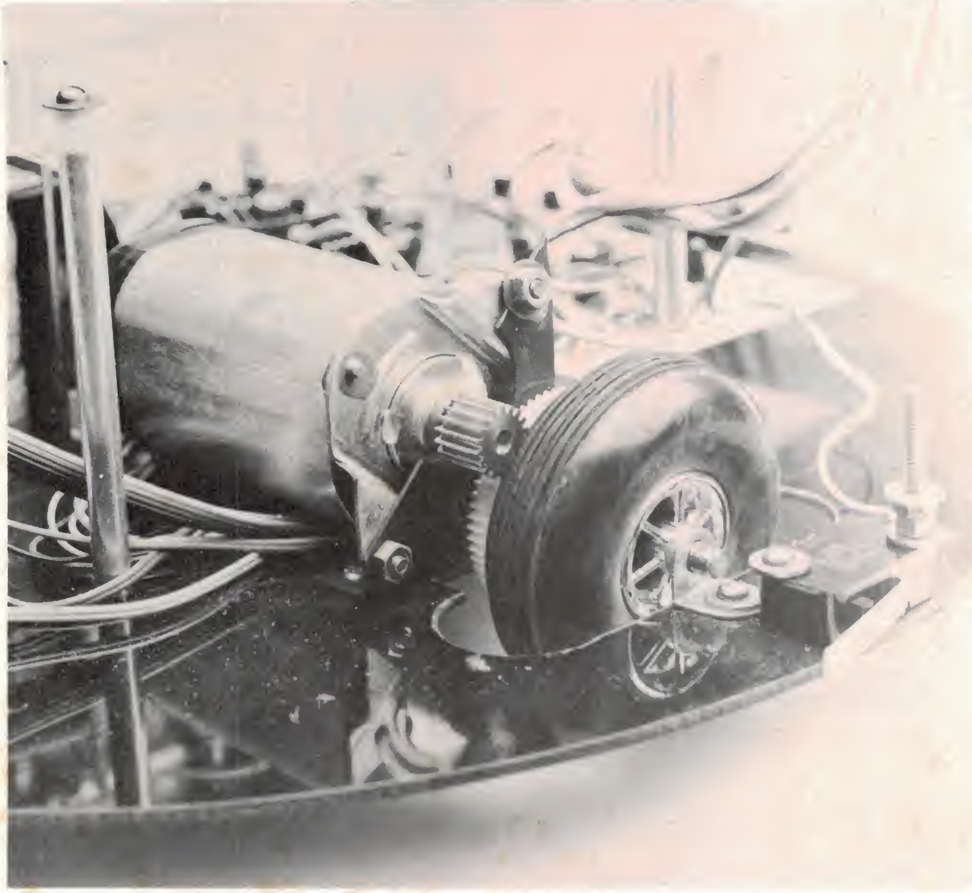



*Figure 7.* **Securing the front face of the motor to the mounting bracket.**

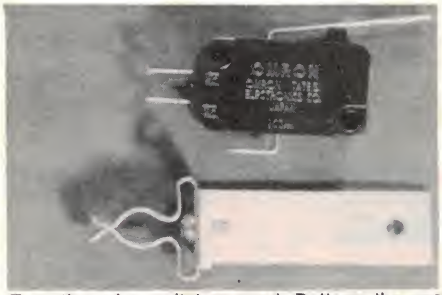
with the end of the motor shaft and tighten the grub screws with the hex key provided. (These require the smaller hex key). Now take the rear motor elbow brackets. Place a ⅛" x ¼" screw in the hole in the small end of the bracket — this is used to secure the end of the motor to the base. Remove the existing end screws in each motor. Secure each bracket to the motor, as per Figure 5, with a ½" x ⅛" screw. Use a washer under each screw head. Note that these brackets are mounted differently on each motor. The motor that will drive the left hand wheel has the wires passing to the right at the bottom of the rear bracket, while the right hand wheel motor has the wires passing to the left of the rear bracket, at the bottom. This means that, when the motors are mounted to the base, the wires pass towards the front of the Turtle.

Take one motor and place the screw hanging from the end bracket through the appropriate hole in the base (see Figure 2), so that the shaft end of the motor butts against the front mounting bracket as per Figure 6. Loosely secure the end bracket with a nut and washer. The brass gear will mesh with the nylon gear and set the wheel assembly in position. Now you can tighten the screw holding the wheel axle elbow, after positioning the elbow so that it is flush with the wheel hub.

The front face of the motor can now be attached to the mounting bracket using ¼" x ⅛" screws. A single washer is placed behind the motor face, as shown in Figure 7. Adjust the meshing of the gears by slightly moving the motor so that the gears mesh well without bending. Finally, tighten all the mounting nuts.



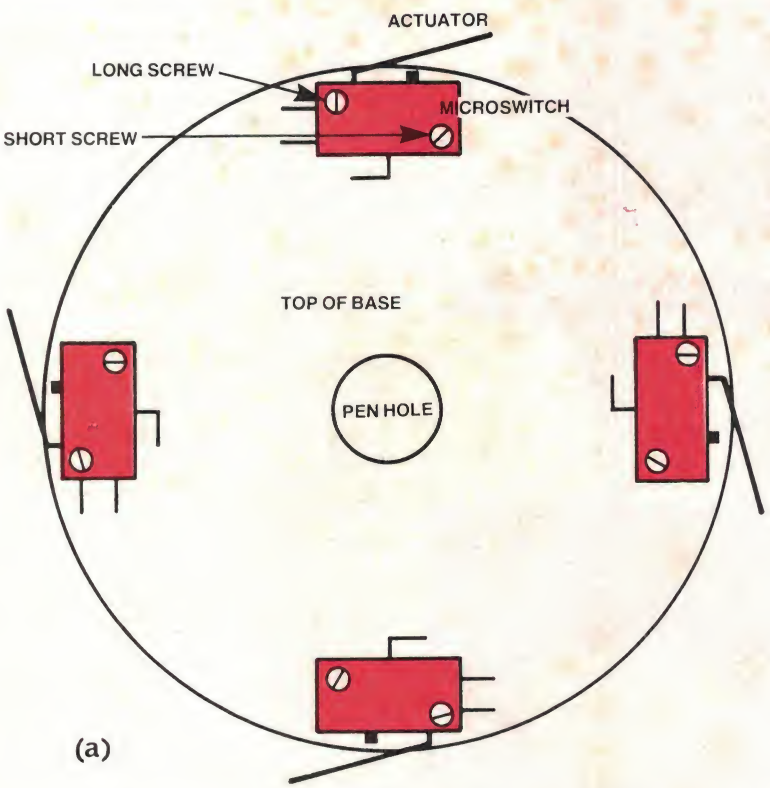
The other motor is mounted in the same way. Check that the motor wires pass along the base toward the front of the Turtle for each motor.



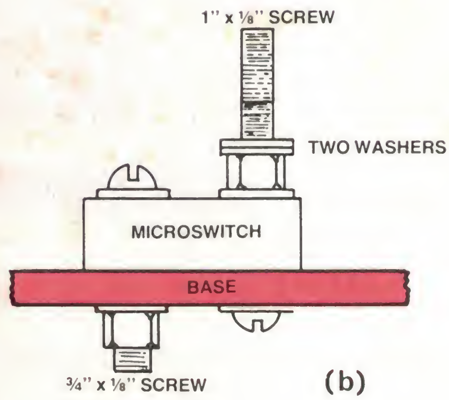
**Top: the microswitches used. Bottom: the pen bracket and pen clamp assembly.**

## Switches

Four microswitches are employed for 'touch' or 'bump' sensors. These are located at 90° intervals around the perimeter of the base. Figure 8a shows their location and orientation. Note that they mount on the top side of the base and the actuators point *clockwise* around the base. Each microswitch is secured by one ¾" x ⅛" screw and one 1" x ⅛" screw. The shorter screw passes down through the switch while the longer passes up through the base, as shown in Figure 8b, the latter also being used to secure the dome.




(a)

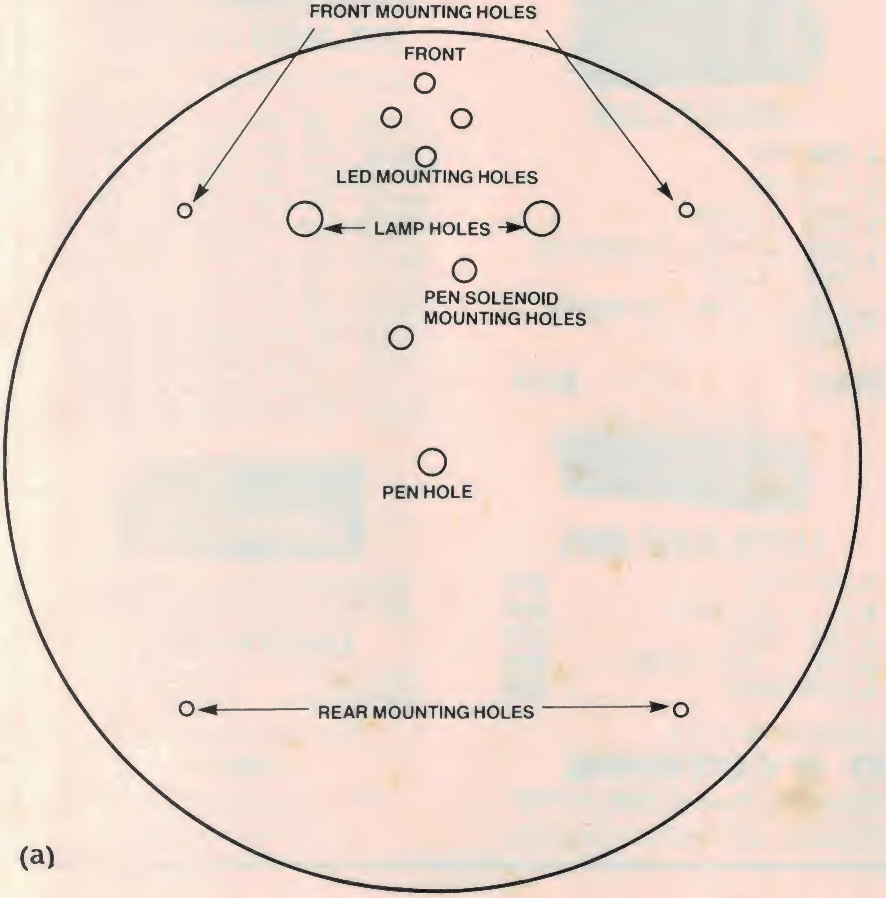



(b)

*Figure 8.* **Locating and mounting the microswitches for the 'touch' or 'bump' sensor ring. (a) Orient the actuators clockwise around the base. (b) The 1" long screw is passed up from under the base through the outermost mounting hole. The ¾" screw passes downwards through the innermost hole. Use washers under each screw head and nut.**

## Inner disc

The clear plastic 230 mm diameter disc is used to mount four LEDs, two lamps and the pen solenoid. Take the disc and orient it as per Figure 9a. Note which holes are used to mount particular components. We can start with the four LEDs. You should have four bezels for them; insert them in the holes and push



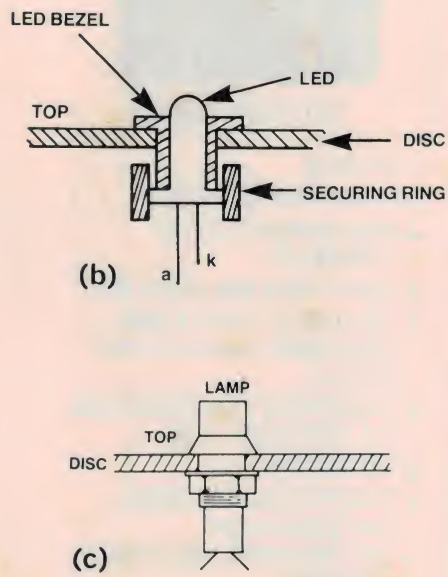




*Figure 9.* **The inner plastic disc. (a) How to identify the various holes. (b) How to mount the LEDs and lamps.**

a LED into each one from beneath. They should snap in. Then push the securing ring over the bezel from beneath (see Figure 9b). Cut the LED leads so that they're about 12 mm (½") long — keep the longer (anode) leads slightly longer for later identification.

Now mount the two green bezel lamps. The bezels go on the top of the disc. These lamps are secured with a large hex nut and a spring washer on the bottom side of the disc.

## Pen solenoid

The pen solenoid mounts on the underside of the inner disc, in the way shown in Figure 10. Note that a washer is placed between the solenoid base and the disc for each of the two mounting screws (¼" x ⅛"). Make sure you orient it correctly as the speaker mounts on the solenoid frame later and it must face the front of the Turtle.

See that the plunger of the solenoid has its keyway toward the front. The pen holder bracket and arm are already assembled and you can screw this assembly onto the solenoid plunger now. The pen solenoid is tightened later on after the pen centring is adjusted.

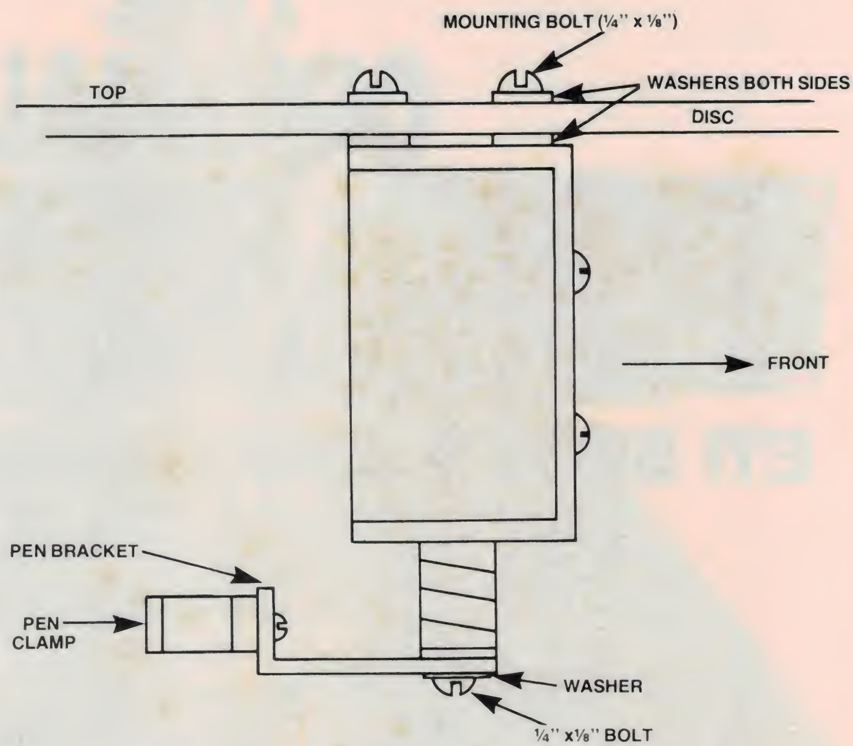



*Figure 10.* **Mounting the pen solenoid.**

## Speaker

Solder the 100 ohm, 1 W resistor to one of the terminals on the speaker after cutting each of the resistor leads to about 12 mm long ●

(. . . to be continued)

SPECIAL OFFER

# TASMAN TURTLE ROBOT KIT

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This product has never previously been offered as a kit and would normally retail for around $600

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Here is a not-to-be-missed opportunity to get started in robotics. For minimum cost this kit will provide you with the basic equipment to construct a robot which can be driven by remote control, electronic hand control or under computer control. Called the 'Minimum Turtle Kit', it has been put together by Flexible Systems of Hobart, Tasmania, manufacturers of the Tasman Turtle (see Printout, page 82, February ETI). Using this kit as a start you can develop a sophisticated robot capable of a huge variety of tasks.

The complete Minimum Turtle Kit comes ready for assembly according to the construction description published in ETI, packed in a box which has been designed so that the Turtle may be housed or stored in it after assembly.

### HOW TO PURCHASE A MINIMUM TURTLE KIT

Fill out the coupon here and include a cheque or money order for a total of $355. Make out the cheque or money order to 'Flexible Systems, Turtle Kit Offer', and post it, together with the coupon, to:

**ETI/Turtle Robot Kit Offer**
**ETI Magazine**
**15 Boundary St**
**Rushcutters Bay NSW 2011**

The orders will be processed by ETI and, on clearance of the cheque or money order by Flexible Systems, the kit will be despatched directly to you by ETI via registered post.

**Alternatively:** You may call in to ETI's Sydney or Melbourne offices at the addresses given below and purchase a Minimum Turtle Kit for $349. A demonstration kit and/or model will be available for inspection during this offer.

**Sydney:** ETI, 4th Floor
15 Boundary St
Rushcutters Bay

**Melbourne:** Murray Publishers, 22nd Floor
150 Lonsdale St
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**Tax exemption:** For schools, TAFEs, etc. this kit can be purchased at the tax exempt price **only** if the coupon is accompanied by a signed order and a tax exemption declaration.

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**Note that the offer expires 30 July 1982.**

*Tasman Turtle is a registered trademark of Flexible Systems.

### WHAT YOU CAN DO WITH IT

You can use your Minimum Turtle to experiment with many aspects of robotics by interfacing it with a computer: draw figures under program command, solve mazes, make measurements, identify objects, etc, etc. It can be driven via a cable or a remote control. The Minimum Turtle has been designed so that a wide variety of add-on projects may be included to increase the sophistication as you desire.

### THE MINIMUM TURTLE KIT CONTAINS:

- **All hardware (base, nuts and bolts, perspex dome, 'touch' ring, pen solenoid, speaker, etc)**
- **All mechanical parts (wheels, gears, axles, two stepper motors, etc)**
- **'Standard Turtle' electronic control pc board and components**
- **All wire and cable for internal wiring**
- **A 25-pin plug for bidirectional data buss, control lines and power supply connections**
- **Comprehensive instruction manual**

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Project 469

# Drum up a storm — with this percussion synthesiser

Design: **Ray Marston**
Development: **Geoff Nicholls**

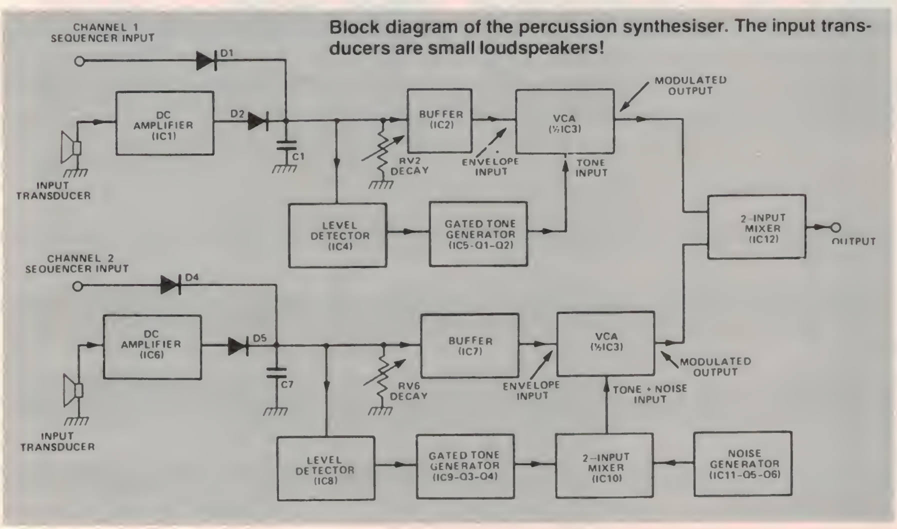
With this instrument you can simulate drums, cymbals, snares and bongos as well as making an assortment of 'wonderful' noises.

THIS ATTRACTIVE musical instrument has two 'percussion simulator' channels, one to simulate the sound of normal drums only, the other to simulate the sounds of all types of drums, including snares, plus metallic percussion sounds such as cymbals, etc. On each channel, the envelope decay times and the basic musical tones, etc, are fully variable, using the manual controls, to enable a wide range of percussion sounds to be simulated. The outputs of the two channels are mixed internally and can be fed to an external power amplifier from a single output socket. The complete instrument may be powered from a 12 V battery pack (8 x AA cells) or a 12 Vdc plug pack supply.

## Design

The synthesiser comprises two essentially similar channels. Channel 1 is built around a voltage-controlled amplifier (half an NE570N). The input signal is modified to produce the characteristic sharp attack, slow decay envelope of percussive sounds. This is done by the input amplifier, IC1, which drives a rectifier, D1, which charges a capacitor, C1. The voltage on this capacitor drives the envelope input of the VCA via a buffer, IC2. C1 is discharged via RV2 — producing the 'decay', RV2 controlling the rate of decay.

A level detector, IC4, also takes its input from C1, and drives a gated tone generator (IC5, Q1, Q2), the output of which provides signal or tone input to the VCA. Thus when the input transducer is struck, the gated tone generator is triggered and its output is modified or modulated by the envelope signal applied to the VCA. The resultant signal is applied to a two-input mixer, IC12.



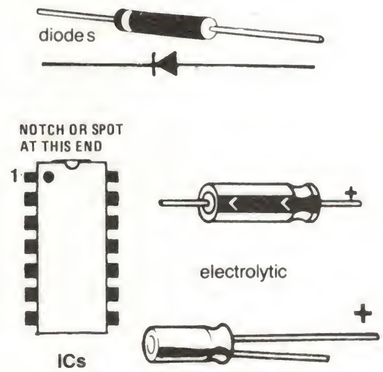
Block diagram of the percussion synthesiser. The input transducers are small loudspeakers!

Channel 2 is largely similar, but has two additions — a noise generator (IC11, Q5, Q6) and a mixer, IC10. The outputs of the noise generator and the Channel 2 gated tone generator are mixed and applied to the signal input of the Channel 2 VCA (the other half of IC3). The 'tone + noise' signal thus produced is modulated by the envelope signal in the same way as before and applied to the other input of the two-input mixer, IC12.

Thus sounds involving a combination of tone and white noise (cymbals, for example) may be simulated, or sounds made up predominantly of white noise (e.g. snares) may also be produced.

Provision has been made for a 'sequencer' so that the synthesiser may be operated 'automatically' to produce a 'programmed' rhythm. We will be describing such a project in a forthcoming issue. ▶

# Project 469


**We housed our project in a light but sturdy ABS plastic case and attached a Scotchcal label to the front panel — artwork for this panel is reproduced on page 126. The two 'transducer' inputs, the output and supply input are located on the rear panel. Small speakers serve as input transducers and are mounted in separate small boxes.**

## Construction

This is best commenced by doing all the mechanical work. The case we used is made by Sigea Australia, a Melbourne-based firm, and is entirely constructed of ABS plastic. It comprises a U-shaped base, the two turn-ups serving as front and rear panels, plus a U-shaped lid which overhangs front and rear. The lid is secured to the base by four screws, two on either side, beneath which two projections extend, serving as feet. The particular case model we used is designated EC.1002. It measures 210 mm wide by 225 mm deep by 80 mm high, overall, and there is ample room inside. Being plastic, it's easy to drill and cut holes in! We understand some kit suppliers will include this case with their kits. However, if you're assembling all the components yourself then any suitable case of adequate size — remember, there are ten pots on the front panel! — will serve the purpose. If you don't have your case ready-drilled, then that's the first job to tackle. Drilling details for the front panel are given in the accompanying diagram. The pc board may be located conveniently in the base of the box and the input and output jacks, etc, mounted on the rear panel to suit yourself.

Cut the potentiometer shafts to suit the knobs being used. The knobs employed on our prototype are a plastic, slip-on variety that are quite cheap and attractive. Ours were obtained from Jaycar, 125 York St, Sydney. These require about 8 mm of shaft beyond the thread.

If you're using a Scotchcal front panel, carefully attach this to the case front panel. Now, identify which pot goes where on the panel and secure each in position, taking care not to damage the Scotchcal on the panel. Note that, from the rear, all the pots face one way — with their terminals to the left. All the knobs are best put on at this stage.

Now you can commence assembly of the pc board. There are five links on the board and these should be inserted first. Follow with the resistors and greencaps. If you are using IC sockets, put these on next, taking care you orient them the correct way. Note that all except IC3 face the same way. The electrolytic capacitors and diodes may be mounted next; make sure you put them in the right way round. Next come the transistors. Watch Q1 and Q3 — the board was originally laid out for transistors having an e-c-b pinout, but most commonly available types have an e-b-c pinout. You'll have to cross the base and collector legs for Q1and Q3, unless you have transistors with the e-c-b pinout.

The pots may be wired next. Wiring between the pc board and the pots is done with ordinary hookup wire. Note that single 0 V hookup wire is best run to the 'earth' end of RV2 first and then to the appropriate lugs of RVs 4, 6, 8 and 10. The 0 V wire connects to the most anticlockwise terminal, when looking at the rear of the pot (see accompanying diagram). Now run the other wires between each pot and the pc board.

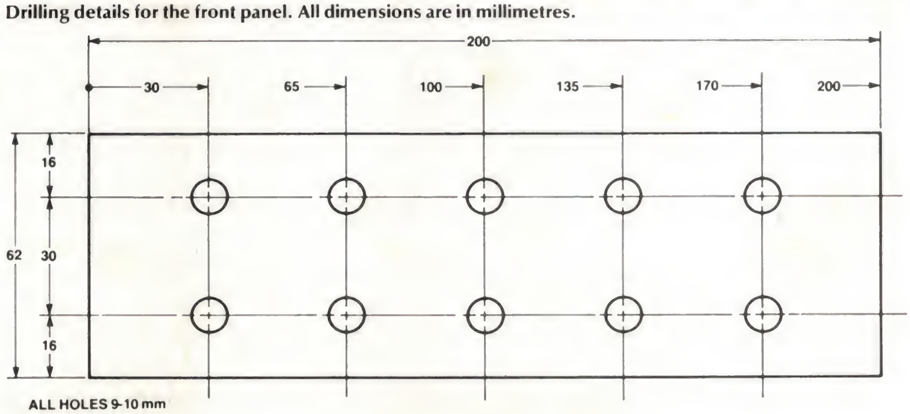
Wire up the input and output sockets. Channel 1 input is wired to RV1, channel 2 to RV5. Wire the power supply leads from the board to the plug pack input socket. Check the polarity of your plug pack — some are wired with −ve to the inner connector, some with +ve.

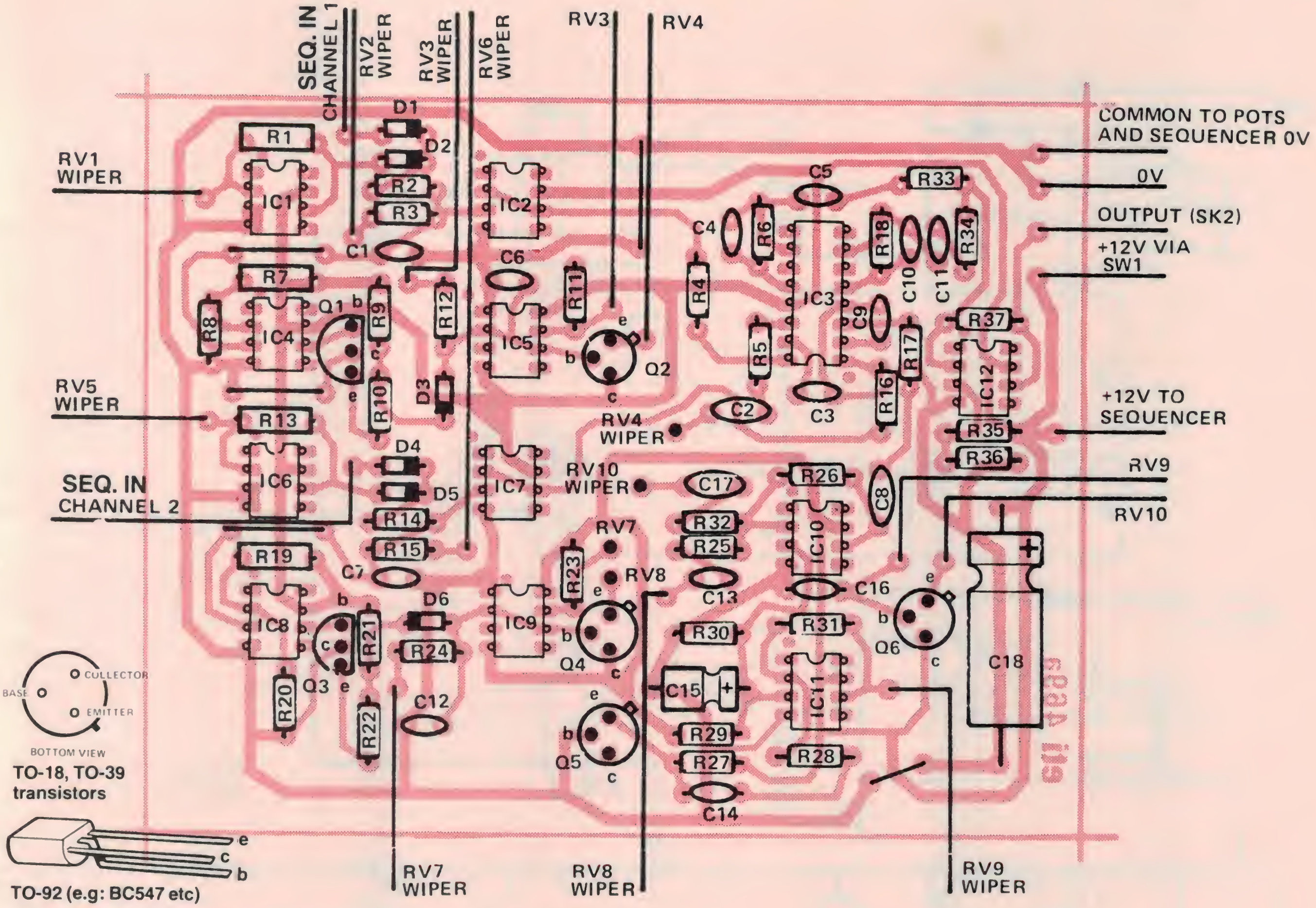
The input 'transducers' are simply small speakers. These may be conveniently mounted in a small jiffy box. You can glue them straight in the bottom — cone down. Tapping the base of the box will cause the speaker to give an output signal. Hook them up with the shielded cable.

Note that the input socket needs to be a stereo, switched type connected such that the two inputs are shorted to 0 V when the input is disconnected. This prevents the input op-amps of each channel from 'floating' with no input, in which case the op-amp offset will give rise to a continuous output — which you don't want!

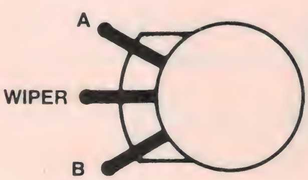
If you're powering this unit from a battery pack, we suggest you obtain one which takes eight 'AA' cells and provides a series connection to produce a nominal 12 V. They come with a handy press-fit connector as found on 9 V transistor radio batteries. The battery pack may be attached to the rear panel in a vertical position, which affords ▶

**Drilling details for the front panel. All dimensions are in millimetres.**






Component overlay. Note that the board has been laid out for the Q1 and Q3 transistors with an e-c-b pinout. Watch the pinout of the transistors you use; you may have to cross the base and collector leads.




### POTENTIOMETER CONNECTIONS

| POT. | A | WIPER | B |
|---|---|---|---|
| RV1 | TO SK1, CH.1 | TO PCB, R1 | — |
| RV2 | — | TO PCB, R3 | TO 0 V |
| RV3 | TO PCB, R11 | TO PCB, R12 | — |
| RV4 | TO PCB, Q2 | TO PCB, C2 | TO 0 V |
| RV5 | TO SK1, CH.2 | TO PCB, R13 | — |
| RV6 | — | TO PCB, R15 | TO 0 V |
| RV7 | TO PCB, R23 | TO PCB, R24 | — |
| RV8 | TO PCB, Q4 | TO PCB, C13 | TO 0 V |
| RV9 | TO PCB, IC11 | TO PCB, C16 | — |
| RV10 | TO PCB, Q6 | TO PCB, C17 | TO 0 V |

## PARTS LIST — ETI-469

**Resistors** ........... all ½W, 5%
R1, 13, 25, 26, 31 .... 1M
R2, 12, 14, 24 ........ 4k7
R3, 15 .............. 33k
R4, 7, 16, 19, 27, 33,
34, 37 .............. 100k
R5, 17 .............. 22k
R6, 18, 35, 36 ........ 47k
R8, 20 .............. 6k8
R9, 21 .............. 1k
R10, 22 ............ 680R
R11, 23 ............ 2k2
R28, 32 ............ 10k
R29, 30 ............ 56k

**Capacitors**
C1, 3, 5, 6, 7, 9, 11,
12, 13 .............. 100n ceramic
C2, 8, 14, 17 ......... 220n greencap
C4, 10 .............. 33p ceramic
C15 ................ 10u/25 V axial electro.
C16 ................ 10n ceramic
C18 ................ 1000u/16 V axial electro.

**Potentiometers**
RV1, 4, 5, 8, 10 ...... 50k lin.
RV2, 6 .............. 2M lin.
RV3, 7 .............. 100k lin.
RV9 ................ 250k lin.

**Semiconductors**
IC1, 2, 4, 6, 7, 8 ...... CA3140
IC3 ................. NE570N
IC5, 9 ............... 7555
IC10, 11, 12 ......... 741
Q1, 3 ............... BC557
Q2, 4, 5, 6 ........... BC549

**Miscellaneous**
SK1 ................ stereo 6.5 mm phone skt with switch
SK2 ................ mono 6.5 mm phone skt
LS1, LS2 ............ 50 mm, 8 ohm speakers

ETI-469a pc board; 10 knobs; case to suit (e.g: Sigea EC.1002); 12 Vdc plug pack (if required); two small jiffy boxes; Scotchcal panel; wire etc.

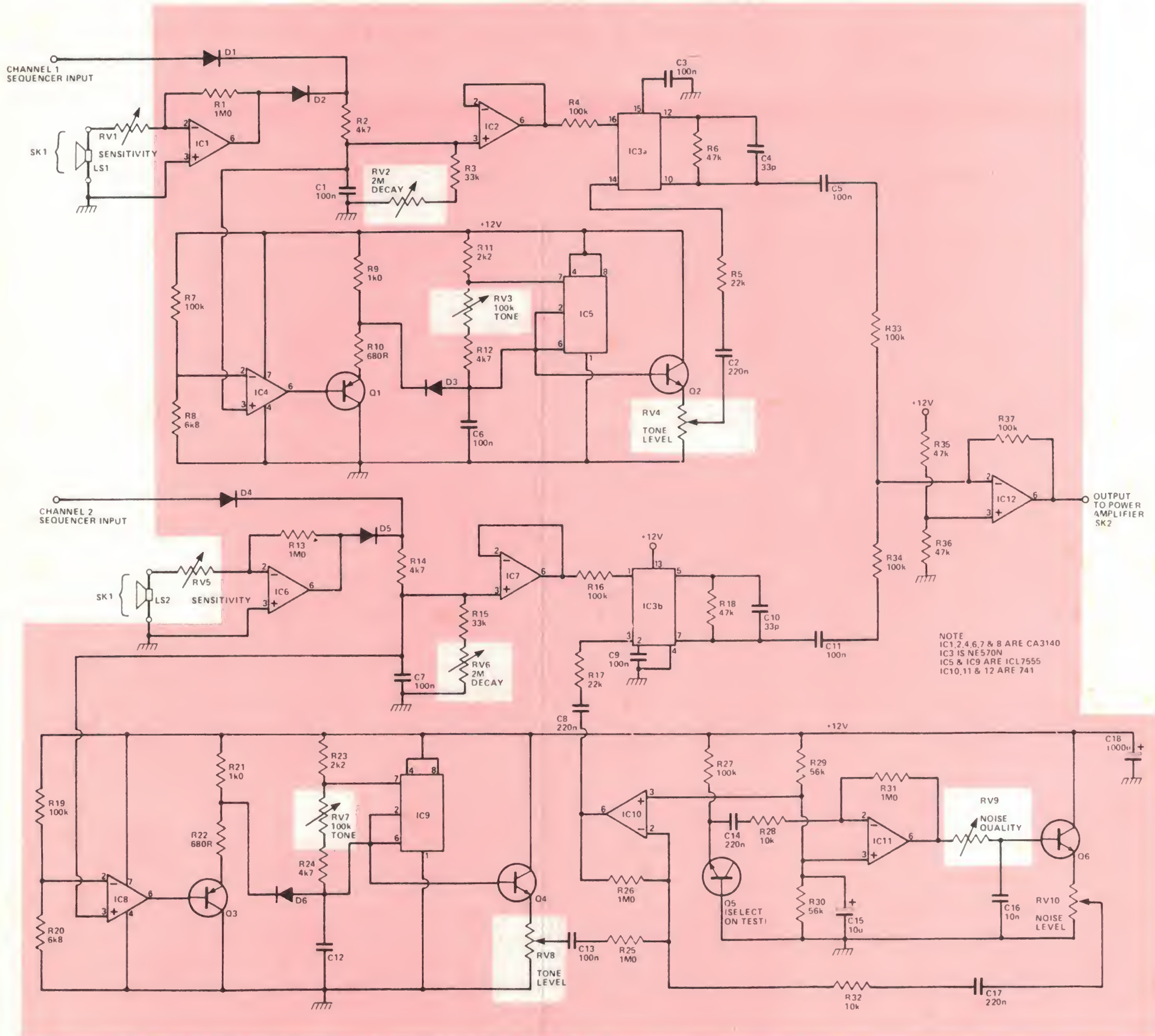
### Price estimate

We estimate the cost of purchasing all the components for this project will be in the range:

**$85 — $95**

Note that this is an **estimate** only and **not** a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.

# Project 469




## HOW IT WORKS — ETI-469

Overall operation is explained in the main text. As the two channels are similar, we'll start the circuit description with the operation of Channel 1, as all the circuit blocks in this channel are common to both channels.

### CHANNEL 1

When used in the manual mode the instrument is played using an external transducer such as a speaker (LS1), which is connected to the input of a high-gain dc amplifier, IC1. Each time the transducer is tapped, the output of IC1 jumps abruptly positive and rapidly charges C1 via D2-R2; C1 then discharges exponentially via R3-RV2, to produce the characteristic fast attack/slow decay modulation waveform of a percussion instrument. The waveform is then fed to one half of the dual VCA, IC3, via unity-gain buffer IC2, where it is used to control the gain of the VCA.

Note that the C1 modulation generator can be activated by either the transducer or by a pulse signal fed to C1 via D1-R1 from the independent sequencer circuit. The C1 voltage is monitored by comparator IC4, which gates on astable IC5 whenever the C1 voltage exceeds a few hundred millivolts. The astable generates a symmetrical ramp waveform, which is buffered by Q1 and fed to the 'tone' input of the VCA via level control RV4. The tone of the astable can be varied over the range 83 Hz to 1.4 kHz with RV3.

Thus each time the channel is activated (by the transducer or by a sequencer) a modulation waveform is fed to one input of the VCA and a tone signal is fed to the other, to produce a modulated tone signal at output pin 10 of IC3. The signal is fed to one input of a two-input mixer, IC12. A wide variety of drum sounds can be simulated by suitable adjustment of RV2, RV3 and RV4.

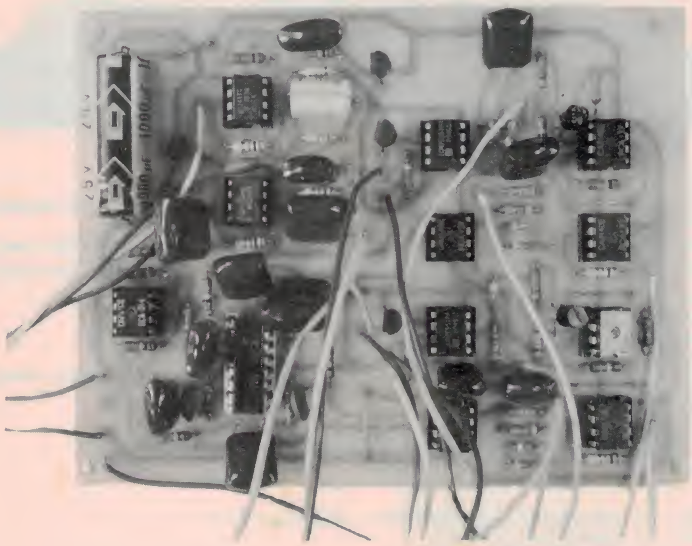
### CHANNEL 2

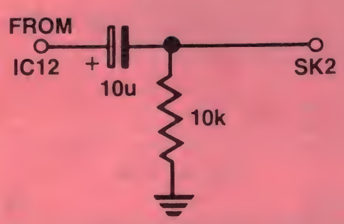
Channel 2 is similar to channel 1, except that the output of the tone generator (from RV8) is fed to the VCA via a two-input mixer designed around IC10. The other input to this mixer is derived from a noise generator designed around Q5-IC11 and Q6. Here, the reverse-biased base-emitter junction of Q5 is used as a noise source and the noise signal is then amplified by IC11, filtered by RV9-C16 and made available via level control RV10.

The instrument is powered from a 12 V supply, derived from eight 1V5 cells. This supply is also used to power the auto-manual sequencer unit.

access to both sides for changing the batteries when necessary. A strip of double-sided sticky pad is ideal for attaching the battery pack. Note that you will need a power switch. A small toggle switch can be mounted on the rear panel in a convenient position or you can get a switch pot for one of the controls (i.e: RV1 or RV5).

Having wired everything up, make the usual visual checks for missed solder joints, solder bridges, dry joints, incorrectly orientated components, etc. Connect the input transducers and the plug pack and connect the sythesiser output to the input of an amplifier. Set the channel 2 sensitivity control fully anticlockwise ('off'). Set all the channel 1 controls to mid position and turn the unit on. It'll probably go 'boing'. Now, tap the channel 1 transducer. You should get a clear 'boing' sound output. If not, check your wiring. Don't forget to check that power is getting to the pc board. If all is well, set all channel 2 controls to the mid point and tap the channel 2 transducer. You should get a 'boing' mixed in with a 'crash'. If it tests out OK, finally secure the pc board in place and put the case together.






NOTE: THE SYNTHESISER OUTPUT IS BIASED AT HALF THE SUPPLY RAIL VOLTAGE AND SOME AMPLIFIER INPUT STAGES MAY OBJECT. THE ABOVE AC-COUPLING CIRCUIT SHOULD BE MOUNTED ON THE REAR OF SK2 IN SUCH CASES.

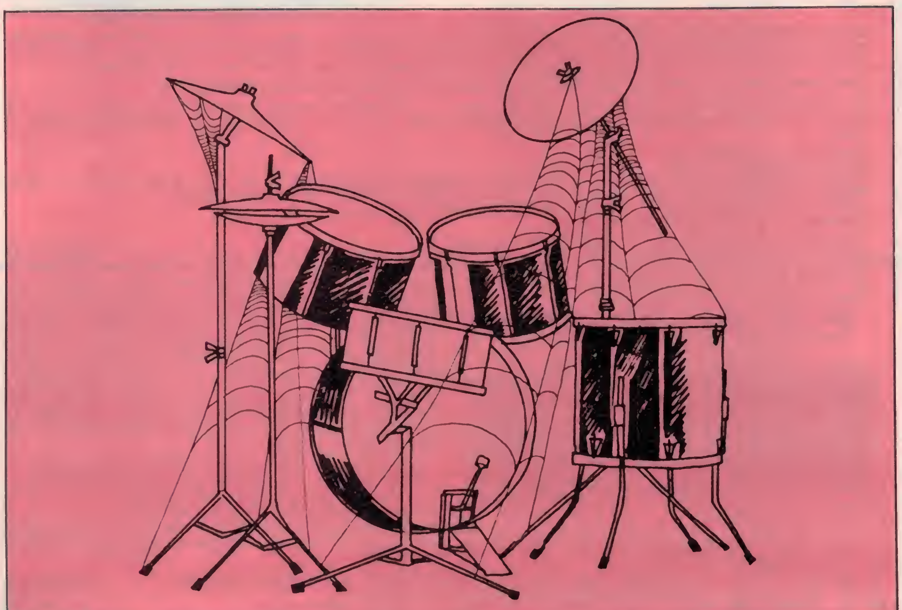
Now, play to your heart's content! You will need to explore how each control functions — how it affects the sound produced — in order to be able to use the synthesiser effectively. There's no substitute for a good fiddle!

## If it doesn't work

There are a few fundamental steps you can take to isolate a fault or faults if the unit doesn't work first off. Obviously, make sure power is getting to the pc board. Check this *at the pc board*. The easiest place to do this is across C18. Trace your power input wiring if all is not as it should be. Next, check that you have all five links installed.

Channel 1 doesn't work? Attach a temporary lead to the channel 1 sequencer input (anode of D1). Briefly touch it on the +ve terminal of C18. You should get a 'boing' in the output (all controls set mid-way). If this works, but tapping LS1 doesn't, look for a wiring fault or incorrect orientation of IC1. Otherwise, there's something awry between IC2, IC3 and IC12. Try temporarily bridging the junctions of R5/C2 and R33/C5. Temporarily disconnect one end of D3. Turn the unit on and you should have a tone output. If not, then look for a fault around IC5, Q2 and possibly IC12. You could use a crystal earpiece to check for a tone at the emitter of Q2 to see that IC5 and Q2 are functioning. If the temporary bridge gives a tone output then check for a fault around IC3. Check that its orientation is correct — it faces the opposite direction to all the other ICs. Remove the bridge and restore D3 when you get it going.

Similar procedure can be applied to channel 2. If the noise generator does not produce noise, try connecting a crystal earpiece to the emitter of Q6. If no noise is present, try using a different transistor for Q5. Note that pin 3 of IC11 should be around half the supply rail voltage. Same goes for IC10. If not, check R29 and R30 for the right values and that IC10 and IC11 are correctly orientated.



## STUDIO FORMAT
## ETI 5000 STEREO CONTROL PREAMPLIFIER

There have been countless accolades exclaiming this brilliant design by Australia's top audio design engineer David Tilbrook — and with good reason.

### SHEER SUPERB SOUND CLARITY

Together with noise levels that would do studio equipment proud.

### PART OF THE SECRET IS . . .

the use of very fast response time "State of the art" OP amp semis, which have only become readily available in recent times.

As a demonstration of our faith in this classic designed preamplifier we proudly release the **STUDIO FORMAT 5000 PREAMP** which includes some very worthwhile refinements as detailed here:—

* Gold plated RCA Jacks on all phono inputs.
* 1 x pair gold plated RCA Line Plugs, supplied.
* Military spec. National Semiconductor LM 394's employed.
* Low capacitance screened cable, supplied; IC sockets provided throughout; Multicoloured led display.
* Metal film 1% resistors used throughout all audio circuitry.
* Pretinned PCB's.
* Satin Black brush finished, aluminium control knobs.

### FACILITIES AND SPECIFICATIONS

**Inputs**

| | |
|---|---|
| Low Level | — Moving coil, moving magnet 1, moving magnet 2. |
| High Level | — Tuner, Aux 1, Aux 2. |
| Tape | — Tape 1, Tape 2. |
| Calibration | — Inbuilt 400 HZ Oscillator. |

**Led Level Meters**

| | |
|---|---|
| Mode selection to | — Source, tape 1 record level, tape 2 record level. |
| Range | — Calibrated — 48 to + 9 db. |
| Display | — Peak and average level simultaneously. |
| Frequency Response | 15 HZ — 130 KHZ + 0 db — 1 DB. |
| Distortion | — Less than .003% all inputs. |
| S/N Ratio | — Greater than 100 db (A weighted) High Level IP/S. Greater than 92 db (A weighted) Moving Magnet IP. Greater than 75 db (A weighted) Moving Coil IP. |
| Monitor Output | — Enables comparison of record level to source levels. |

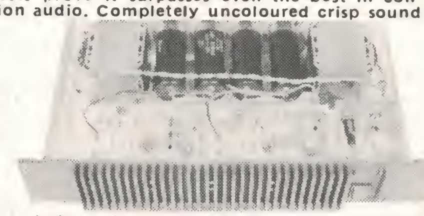
**DELUXE STUDIO FORMAT 5000 PREAMP KIT** K 5001 . . . **$275.00**

Complete kit includes all ETI specified parts plus the Studio Format Package. Full instruction booklet included.

SEE ETI MAGAZINE JULY '81—OCT. '81 FOR FULL DETAILS.

## ETI 5000 STEREO MOSFET AMPLIFIER

**See ETI magazine Jan. '81—April '81. New generation mosfet power semis facilitate David Tilbrook's classic power amplifier. Listening tests prove it surpasses even the best in conventional amplifiers in low fatigue, high definition audio. Completely uncoloured crisp sound purity.**



**EVEN BETTER:** This beautifully engineered amp design is based principally on two identical printed circuit boards with a minimum of other wiring, thus enabling even a relative "beginner" to accomplish building this project as long as the step by step instructions are followed.

**The Altronics Kit includes the DELUXE FINISH FRONT PANEL HEATSINK.**

* Original specified chassis bar design case. * All metal work finished satin black. * Flux shorting strap transformers used to minimise hum * Low leakage power supply electrolytics used.

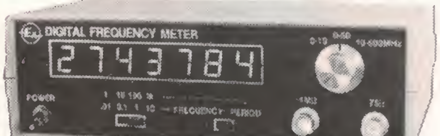
**SPECIFICATIONS:**
**Power Output:** 100 watts into 8 ohms x 2. **Frequency Response:** 8 HZ - 20 KHZ + 0 db — .4 db. **Noise:** 116 db below full output. **Input sensitivity:** IV RMS for 100 W output. **DISTORTION:** Less than .001% at 1 KHZ and full output. **STABILITY:** Unconditional stable.

COMPLETE MOSFET AMP KIT K 5005 . . . . . . . . . . . . . . . . . . . . . . **$289.00**

## DIGITAL FREQUENCY METER

See Electronics Aust. Mag. Dec. 81-Feb. '82

**500 MHZ, 7 DIGIT RESOLUTION PLUS PERIOD MEASUREMENT FEATURE**




**IMPORTANT NOTES:**
(1) This project is well within the scope of the "not so experienced" as virtually all components are contained on a single PCB.
(2) **ALTRONICS USE ONLY THE SPECIFIED INTERSCIL LSI — BEWARE OF INFERIOR KITS THAT DO NOT CONFORM TO THE ORIGINAL DESIGN.**

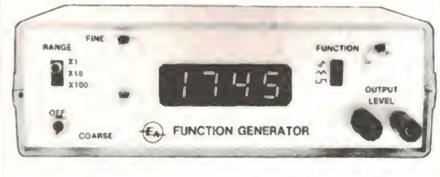
* Prepunched and screened front panel, no drilling or filling required. * Bright high efficiency 7 segment display. * Frequency ranges 0-10MHz, 0-50MHz, 10-50MHz (with optional pre-scaler) * 4 gating times — 01, .1, 1, 10 seconds. * 4 period measuring ranges 1, 10, 100 and 1000 input cycles give 0.1uS resolution. * High input sensitivity — 10mV to 30MHz, 100mV at 50MHz @ 1M input impedance, 200mV at 500MHz @ 75 ohms input impedance. * High accuracy — typically better than .005%/count uncalibrated.

Costs a fraction of commercial counters.

**EXCLUSIVE ALTRONICS KIT FEATURES:**
* IC sockets provided throughout.
* Low aging 10,000 MHZ XTAL.
* Thermalloy heatsink for 5V regulator.
* Quality Pactec Instrument Case with tilting bail.

K 2500 (50 MHZ version) . . . . . **$119.50**
K 2501 Pre-scaler . . . . . . . . . . **$ 26.00**
(add for 500 MHZ version)

## FUNCTION GENERATOR WITH DIGITAL DISPLAY




EA's new Function Generator covers the frequency range from 15Hz to 170kHz in three ranges with coarse and fine frequency controls. An economical 4-digit display has been incorporated to eliminate dial calibration. Sine wave distortion can be trimmed to around 0.5%.
See EA April, 1982

K 2505 . . . . . . . . . . . . . . . . . . **$79.50**

## ALTRONICS POWER SUPPLY

**BASED ON EA LM 317K PROJECT**
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* Overload and short circuit protected.
* Full voltage and current metering.
* 3-32 volt output at 1 AMP.
* Uses LM 317K variable regulator.
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**VALUE PLUS!**

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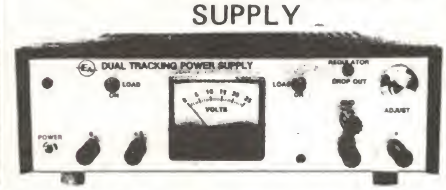
## DIGITAL CAPACITANCE METER

Electronics Australia Project. Measures 1PF — 99.99 UF. 240V Mains Powered. Bright LED Display. Easy to build. Complete kit of parts and full instructions.

K 2520 . . . . . . . . . . . . . . . . **$45.00**

## DUAL TRACKING POWER SUPPLY

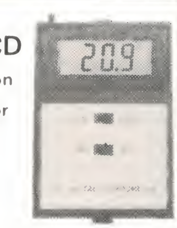



+ and — 22V up to 2 AMPS
+ 5V at .9 AMP
Fully Protected against short circuits, overloads and thermal runaway.
See EA March, 1982

K 2507 . . . . . . . . . . . . . . . . **$86.00**

## DIGITAL THERMOMETER LCD

See EA Feb. '82. Fantastic new project. * 1°C Resolution * Has inbuilt sensor for portable use * External sensor capacity allows measurement of fish tanks, heatsinks etc. Uses brand new DPM-200 15mm LCD Display. Easy to build.




K 2530 . . . **$59.95**

# CLAMP METER

## MODEL YF-700

Top of the range model AC Voltage 150V 300V 600V AC Current 6A 15A 60A 150A 300A. Resistance 5kΩ (Midscole 200Ω)

**was $49.99**

**NOW ONLY**

# $43.55

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| ITOH 8300 PARALLEL | $668 + TAX |
| ITOH 8300 SERIAL | $730 + TAX |
| ITOH 1500 PARALLEL (DAISYWHEEL) | $1515 + TAX |
| ITOH 1500 SERIAL (DAISYWHEEL) | $1555 + TAX |
| ITOH 8510 PARALLEL | $910 + TAX |
| ITOH 8510 SERIAL (GRAPHIC ETC) | $1015 + TAX |

RITRON COMPUTER GRADE P/S
+5V reg 10a 16V unreg @ 1A
KIT $79.95 inc
Built and tested $99.50

ETI636 MOTHERBOARD
7 Slot Motherboard $90.00
Built and Tested $120.00
ACTIVELY TERMINATED

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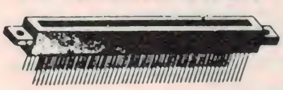
**3½ DIGIT PANEL METER KITS**

**Build a working DPM in ½-hour with these complete evaluation kits.**
Test these new parts for yourself with intersil's low cost prototyping kits complete with A/D converter and LCD display (for the 7106) or LED display (for the 7107). Kits provide all matrials including PC board, for a functioning panel meter ICL7106EV (LCD)

**P.C. EDGE CONNECTORS**



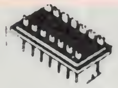
| | |
|---|---|
| S100 gold plated wire wrap | $8.50 |
| S100 solder tail | $6.90 |
| D2 Motorola bus | |
| 43/86 solder tail | $8.50 |
| 43/86 gold plated wire wrap | $11.50 |

**10 TURN POTENTIOMETERS**

Stock resistance values
50R, 100R, 200R,
500R, 1K, 2K, 5K,
10K, 20K, 50K,
100k

Spectrol model 534 ¼" shaft
Price 1 — 9 $9.50
10 + values may be mixed $8.90

**DIP PLUGS**



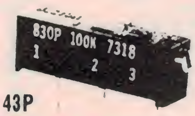
Ideal for use with flat ribbon cable or to mount components on
14 pin $1.20 — 24 pin $1.20
16 pin $1.40 — 40 pins $5

**POWER TRANSFORMERS**

SPECIALLY DESIGNED FOR MICROCOMPUTERS

- Good regulation electrostatic shield
- RI 810 8V @ 10A x 15V @ 1A $26.50
- RI 820 8V @ 20A 15V @ 1A 15V @ 3A $36.50

**20 TURN CERMET TRIM POT**



**SPECTROL 43P ACTUAL SIZE**

STOCK RESISTANCE VALUES
10R, 20R, 50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1M, 2M

| | |
|---|---|
| 1—9 | $1.40 |
| 10—99 | $1.30 |
| 100 | $1.20 |

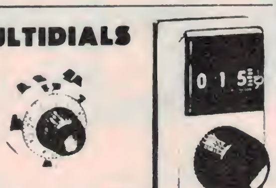
Values may be mixed.

**Hexadecimal Keypad**
**$28.50 each**

19-key pad includes 1-10 keys ABCDEF and 2 optional keys and a shift key

**Ideal for dream project**

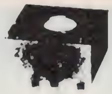
**MULTIDIALS**



Dials to suit 10 T Pots

| | |
|---|---|
| Model 21 1.8" dia | $16.50 |
| Model 16 9" dia | $12.50 |
| Model 18 1" x 1.75" dia | $21.50 |

**cermet single TURN TRIM POT**



Spectrol model 63P
ACTUAL SIZE

STOCK VALUES
10R, 20R, 50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 200K, 500K, 1M, 2M

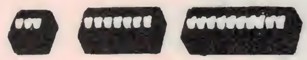
| | |
|---|---|
| 1—9 | $1.00 |
| 10—99 | 0.90 |
| 100 | 0.80 |

Values may be mixed.

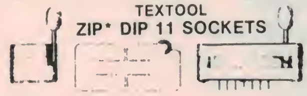
**DIP SWITCHES SPST**

| P N | No of Switches | Price |
|---|---|---|
| SD3 | 3 | $1.60 |
| SD4 | 4 | 1.70 |
| SD5 | 5 | 1.90 |
| SD6 | 6 | 2.30 |
| SD7 | 7 | 2.40 |
| SD8 | 8 | 2.50 |
| SD9 | 9 | 2.70 |
| SD10 | 10 | 3.00 |

**DIP SWITCHES SPST**



TEXTOOL
ZIP* DIP 11 SOCKETS



| | |
|---|---|
| 16 Pin Zip* Dip 11 | $11.50 |
| 24 Pin Zip* Dip 11 | 12.50 |
| 40 Pin Zip* Dip 11 | 17.50 |

*Zero Insertion Pressure

**INCREDIBLE MEMORY AND DISC DRIVE PRICES**

| | 1-9 | 10-25 | 25+ |
|---|---|---|---|
| 2708 | 4.90 | 4.00 | 3.90 |
| 2716 | 4.90 | 4.20 | 3.90 |
| 2732 | 8.00 | 7.50 | 7.00 |
| 4116 (200nS) | 1.95 | 1.80 | 1.75 |
| 4164 64K Dynamic | 11.00 | 10.00 | 9.50 |
| M58725P (2K x 8) Static | 10.00 | 9.00 | 8.50 |

(As used in new 64K Static S100 PCB)
ALL PRICES INCLUDE SALES TAX

**DISK DRIVES**

MPI 51 $275.00 + 17.5% ST
MPI 52 $385.00 + 17.5% ST
MPI 91 $415.00 + 17.5% ST
MPI 92 $515.00 + 17.5% ST.

**TANDON**

TM100-1 $295.00 + 17.5% ST
TM100-2 $385.00 + 17.5% ST
TM100-3 $415.00 + 17.5% ST
TM100-4 $515.00 + 17.5% ST

**BUILD YOUR OWN SPEAKERS WITH PHILLIPS**

| PART No | PRICE |
|---|---|
| AD0140TB | $11.86 |
| AD016101TB | $16.95 |
| AD01605-TB | $16.54 |
| AD0162-T15 | $18.78 |
| AD0162-T15 | $13.03 |
| AD0162-TB | $13.77 |
| AD0210-SQ8 | $32.70 |
| AD02160-SQ8 | $36.91 |
| AD02161-SQ8 | $33.46 |
| AD10100-W8 | $52.72 |
| AD12100-HP8 | $85.10 |
| AD12100-M15 | $79.11 |
| AD12100-M8 | $79.11 |
| AD12100-W8 | $53.99 |
| AD12200-W8 | $73.12 |
| AD12250-W8 | $90.52 |
| AD12650-W8 | $73.12 |
| AD2273-T8 | $5.03 |
| AD4060-W8 | $19.06 |
| AD5060-SQ4 | $22.05 |
| AD5060-SQ8 | $22.05 |
| AD5060-W8 | $17.59 |
| AD5061-MB | $17.08 |
| AD70601-W8 | $20.40 |
| AD70620-M8 | $21.54 |
| AD7063-M8 | $20.78 |
| AD70630-M8 | $20.78 |
| AD70650-W8 | $26.96 |
| AD7066-W8 | $26.96 |
| AD80601-W8 | $20.24 |
| AD8061-W8 | $20.24 |
| AD80652-W8 | $26.20 |
| AD8066-W4 | $27.66 |
| AD8081-M8 | $9.81 |
| AD9710-M8 | $41.11 |
| ADF1600-8 | $19.44 |
| ADF500-4500-8 | $19.44 |

**DIODES**

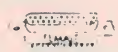
| | 10-99 | 100+ |
|---|---|---|
| IN4001 | 6c | 5c |
| IN4002 | 6c | 5c |
| IN4004 | 7c | 6c |
| IN4148 | 5c | 4c |
| IN5404 | 30c | 25c |
| IN5408 | 35c | 30c |
| IN4007 | 12c | 11c |

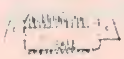
**HEATSINKS**

**High Thermal Capacity Black Anodised**

| | 1-4 $ | 5-9 $ | 10-49 $ | 50-99 $ | 100-499 $ | 500 plus $ |
|---|---|---|---|---|---|---|
| HS1 — 38mm | 1.85 | 1.75 | 1.50 | 1.35 | 1.00 | 0.90 |
| HS2 — 75mm | 3.00 | 2.90 | 2.50 | 2.00 | 2.00 | 1.50 |
| HS3 — 150mm | 5.80 | 5.40 | 4.90 | 3.80 | 2.90 | 2.70 |
| HS4 — 225mm | 8.10 | 7.60 | 7.10 | 5.90 | 4.50 | 4.30 |
| HS5 — 300mm | 8.90 | 8.40 | 7.90 | 6.50 | 4.90 | 4.60 |
| **Unanodised** | | | | | | |
| HS11 — 38mm | 1.40 | 1.20 | 1.00 | 0.90 | 0.80 | 0.70 |
| HS12 — 75mm | 2.50 | 2.20 | 1.90 | 1.60 | 1.25 | 1.20 |
| HS13 — 150mm | 4.90 | 4.50 | 4.00 | 3.20 | 2.45 | 2.40 |

**RS232 & "D" TYPE CONNECTORS**





| PART NO | DESCRIPTION | 1-9 | 10-25 | 25+ |
|---|---|---|---|---|
| DE 9P | 9 PIN MALE | $3.50 | $3.50 | $3.10 |
| DE 9S | 9 PIN F/MALE | 4.50 | 4.20 | 3.90 |
| DE 9C | 9 PIN COVER | 2.20 | 2.10 | 1.90 |
| DA 15P | 15 PIN MALE | 4.50 | 4.20 | 3.90 |
| DA 15S | 15 PIN F/MALE | 5.10 | 4.90 | 4.70 |
| DA 15C | 15 PIN COVER | 2.30 | 2.10 | 2.00 |
| DB 25P | 25 PIN MALE | 5.90 | 5.60 | 5.10 |
| DB 25S | 25 PIN F/MALE | 6.90 | 6.60 | 6.10 |
| DB 25C | 1 pc Grey Hood | 2.40 | 2.20 | 2.00 |
| DB 25C2B | 2 pc Black Hood | 2.80 | 2.70 | 2.50 |
| DB 25C2G | 2 pc Grey Hood | 2.70 | 2.50 | 2.40 |
| DC 37P | 37 PIN MALE | 7.90 | 7.50 | 7.10 |
| DC 37S | 37 PIN F/MALE | 10.90 | 9.90 | 9.10 |
| DC 37C | 37 PIN COVER | 4.90 | 4.50 | 4.10 |
| DH S | Hardware set (2 Pairs) | 2.10 | 1.90 | 1.80 |

**BLANK CASSETTES T.D.K.**

| | | |
|---|---|---|
| TDK ADC60 | 1 for $3.60 | 10 for $26.00 |
| TDK DC60 | 1 for $2.10 | 10 for $18.00 |
| TDK ODC60 | 1 for $3.50 | 10 for $31.00 |
| TDK SAC60 | 1 for $3.30 | 10 for $29.00 |
| TDK SAXC60 | 1 for $5.70 | 10 for $46.00 |
| TDK DC90 | 1 for $3.05 | 10 for $21.00 |
| TDK ADC 90 | 1 for $3.50 | 10 for $28.00 |
| TDK SAC 90 | 1 for $4.20 | 10 for $37.00 |
| TDK ODC90 | 1 for $4.70 | 10 for $45.00 |
| TDK SAXC90 | 1 for $5.50 | 10 for $49.00 |
| TDK DC120 | 1 for $4.50 | 10 for $37.00 |
| TDK ADC120 | 1 for $5.40 | 10 for $46.50 |

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# ROD IRVING ELECTRONICS

**425 HIGH STREET, NORTHCOTE 3070, MELBOURNE, VICTORIA. Ph (03) 489 8131. Telex No. 38897**

# Ideas for Experimenters

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.

## Square wave and pulse generator

This hobbyists' square wave and pulse generator can be built in a jiffy box and powered with a 9 V battery. It is meant as a clock, to power IC experiments.

With S1 to the right, square waves are generated in five overlapping ranges, each variable 10:1, via RV2. Total range is about 1 Hz to 100 kHz.

With S1 to the left, five fixed frequencies are generated: 10 Hz to 100 kHz, as selected by S2. The pulse width is variable in this mode. RV1 alters the duty cycle 1% through 99%, on the time-base of the frequency selected.

Table 1 shows the value of capacitors required, whilst table 2 shows the pulse widths available.

To test, connect an 8 ohm speaker in series with a 100R resistor and a 100 uF capacitor between the output and 0 V. Through the audio range it will squeal; when in the LF/short-pulse mode, it will click.

Quite a neat idea, from **Ron Mellor of Peakhurst, NSW.**

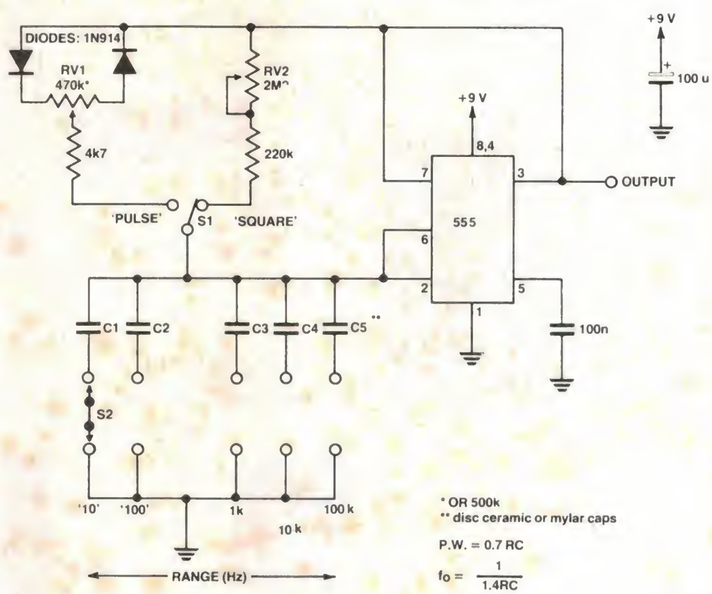



TABLE 1

| | |
|---|---|
| C1 | 330n |
| C2 | 33n |
| C3 | 3n3 |
| C4 | 330p |
| C5 | 33p |

TABLE 2

| RANGE (Hz) | PULSE WIDTH RANGE (RV1) |
|---|---|
| '10' | 1 ms - 100 ms |
| '100' | 100 us - 10 ms |
| '1k' | 10 us - 1 ms |
| '10k' | 1 us - 100 us |
| '100k' | 100 ns * - 10 us |

* may not achieve

## Auto-reverse for split-phase motors

The idea with this circuit, from **Kris McLean of Granville Tech. College NSW,** is to provide automatic reversing under load for an ordinary split-phase motor of the type used on drill presses and some garage door openers.

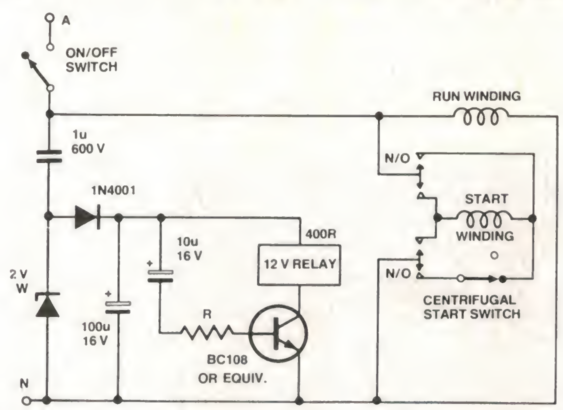
Resistor 'R' is chosen such that the relay is not energised so long that the start winding overheats, but is such a value that the relay contacts do not drop out before the starting switch has opened, causing the motor to spontaneously reverse. A period of around half a second for R between 10k and 1M seems best.

At switch-on the relay pulls in momentarily, the normally open contacts close briefly and give the motor a start in the right direction. Shortly before reaching full rpm, the motor's internal starting switch opens and the relay drops out.

Now, when the motor loads up, the loss of rpm causes the centrifugal switch to close and thus reverses the motor.

The circuit's one disadvantage is that synchronous single-phase motors maintain their rpm under quite drastic loads and as such a reverse can only be initiated just prior to a stall condition. To get a more sensitive response involves altering the springs on the centrifugal starting switch.

Note that the relay contacts should be rated at 15 or 20 A.




### ATTENTION

**Double Density Computer Cassette Storage:** This idea appeared on the bottom of page 57 of the February issue. It only works with decks that have **a split erase head.** Otherwise, when recording on one track, any recording on the other track will be erased.

# BRILLIANT NEW KITS FOR '82!

JAYCAR IS AUSTRALIA'S LARGEST SELLER OF THE 5000 SERIES KITS BY FAR — THERE MUST BE A REASON!

## 500MHz Digital Frequency Period Meter

REF: EA Dec '81 — Feb '82

500MHz option only $26 extra

50MHz Version $119


ONLY $119

Tilting Bail to suit ONLY $4.95

Other people may appear to be selling this kit for less. But you GET less!!! Exclusive Jaycar features:
* Heavy gauge front panel. Pre-punched, and silkscreened. (NOT Scotchcal). * Low aging rate 10.000 MHz crystal * Quality IC sockets provided (A MUST) * All metal film resistors used (1% 50ppm) *Thermalloy heatsink for +5V regulator

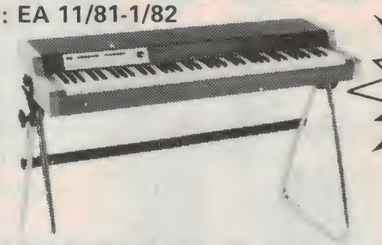
Beware of advertised units that do not conform to the original design. They may have inferior performance.

THE BEST QUALITY KIT VERSION OF THIS PROJECT IN AUSTRALIA

## Lyrebird Piano Kit

**NEW LOW PRICE....**

REF: EA 11/81-1/82



$475

SAVE $50!!!

NEW LOW PRICE!! Because we are shipping keyboards and other expensive components in bulk due to high demand, we can pass savings on to YOU.

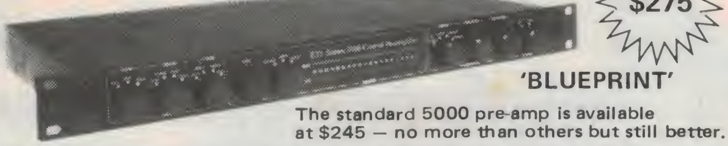
You can now have a magnificent "Lyrebird" 6 octave touch sensitive piano now for only $475!! That's a staggering $50 off the old price.

REMEMBER!! THE LYREBIRD OUTPERFORMS READY BUILT PIANOS COSTING UP TO THOUSANDS OF DOLLARS MORE. WHY PAY MORE WHEN YOUR CONSTRUCTION KNOWLEDGE CAN SAVE YOU A FORTUNE?

## Brilliant 5000 Series Amps — "NO COMPROMISE"

$299

SUPERFINISH



$275

'BLUEPRINT'

The standard 5000 pre-amp is available at $245 — no more than others but still better.

It is pleasing to see that many, many hundreds of Australians appreciate a quality kit when they see IT. The 5000 MOSFET P.A. and Pre-amp are so good they are attracting International interest. (We will be exporting our first shipment of these to - would you believe an Asian country - as you read this). Many people still can't comprehend their current performance specs make them the BEST amps in the WORLD.

WRITE FOR A FREE LEAFLET

## Sub-Woofer Sensation

Many of you have followed the recent articles in EA regarding the design of vented loudspeaker enclosures. The natural progression of this discussion was a description of a vented speaker system. At the same time we were concerned that the most critical component, the low frequency driver must be of high quality with consistent Qt and Vas.

Jaycar has had such a speaker made! The unit has been specially manufactured for us to our specs. It is ideal for subwoofer applications based on the work of Thiele, Small and Snyder.

SPECS: Diameter 10" (250mm) cast frame * QT= 0.39 * VAS= 631 * Power Handling: 100W (RMS) * Voice Coil = 2" (51mm) dia. * Magnet Assy. = 3kg (6.6lbs).

Because of bulk buying we have been able to bring this unit to you at an unbelievable price. Normally this unit would sell for well over $100 (they are overseas).

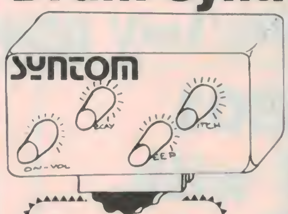
THE INTRODUCTORY PRICE FOR THIS UNIT? ONLY $79.50

A FREE SUBWOOFER CABINET DESIGN IS PROVIDED WITH EACH UNIT!

**ONLY $79.50 ea**

## Drum Synthesiser Kit

As used by WARREN CANN of "ULTRAVOX"

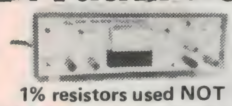



$36·50

Original design from the UK magazine "Electronics and Music Maker" April 1981. Self-contained unit produces a variety of fixed and falling pitch effects. Trigger by tapping the unit itself or by striking a drum to which the unit is attached. The Jaycar "SYNTOM" comes complete with high quality pre-drilled moulded all ABS box 152 x 80 x 47mm with professional silk-screened front panel.

FEATURES: Decay from less than 0.1 second to several seconds, pitch control, sweep control and volume on/off.

## EA dual tracking P/S



EXCLUSIVE!! US—MADE 10 TURN .25% LINEARITY POT used for greater accuracy

$84.50

Ref: EA March '82

1% resistors used NOT 2%.

At last!! A dual-tracking power supply with fixed +5V reg. at a reasonable price!!

YOU PAY NO MORE FOR A QUALITY JAYCAR KIT!!

## New EA FUZZ BOX $19.50

Ref: EA Feb '81

COMPLETE KIT

The engineers at Jaycar have come up with a great version of this versatile kit. The kit features a heavy duty footswitch — a must for the serious stage muso.

## ETI 158 LOW OHMS METER

Ref: Nov '81 ETI

$29.50

This extremely handy kit is now available from US. Even capable of testing dry solder joints!! Complete kit inc. case & large meter.

**Jaycar**

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$100 up ($5.50)

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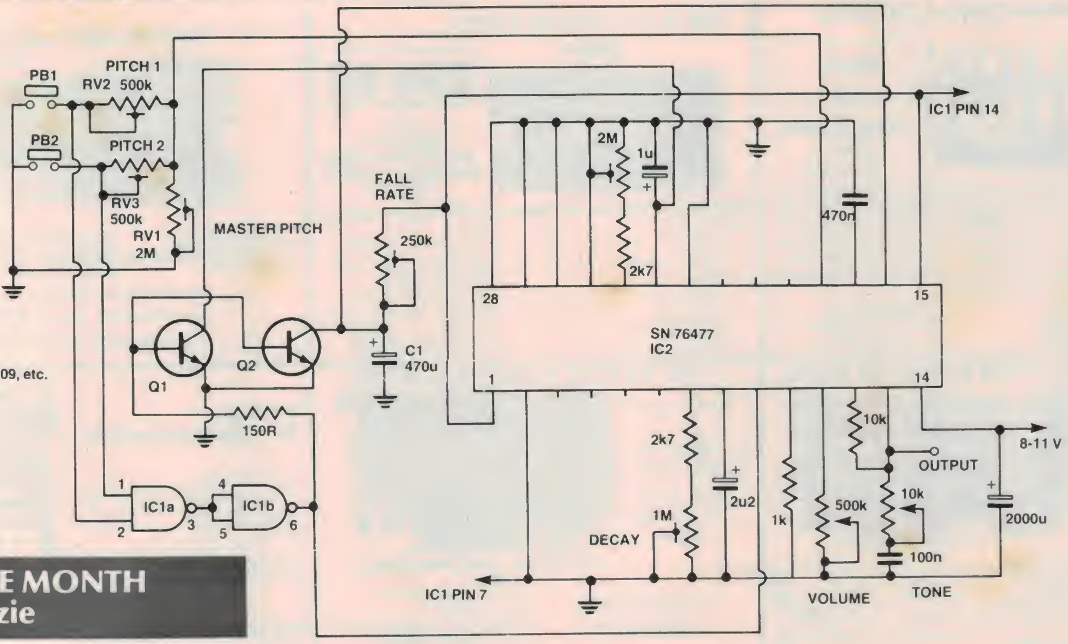
# Ideas for Experimenters




**IDEA OF THE MONTH**
**R.K. McKenzie**

## Simple drum synth.

'Electronic drums' are used by a number of pop groups, and this circuit will simulate the sounds produced by a drum synthesiser — but cheaply.

Commercial drum synthesisers use some sort of pressure-sensitive transducer for input — but they're next to impossible to make so I used pushbuttons instead. Keyswitches are another possibility.

The unit is built around the SN76477 Complex Sound Generator IC from Texas Instruments (IC2). Capacitor C1 causes IC2 to produce a falling pitch as it charges, the rate being controlled by RV1. Q1 and Q2 ensure that the pitch will trigger at the same place when either button is pressed. IC2 contains a voltage-controlled oscillator which provides a square wave output at pin 13. As this can sound harsh, a tone control was added to give a similar sound to the commercial units.

Almost any transistors can be used for Q1 and Q2, and a single AND gate from a 7408 could replace the two NAND gates from the 7400 (IC1).

Construction proved non-critical and any power supply from 8 to 11 volts **(but no higher — Ed.)** may be used as IC2 contains a 5 V regulator. The output is connected to an amplifier and RV1, RV2 and RV3 are adjusted to provide the pitches desired. The remaining potentiometers may be varied to achieve the desired sound.

64K SS50 STATIC NOW AVAILABLE $399 + TAX
64K S100 STATIC NOW AVAILABLE $399 + TAX
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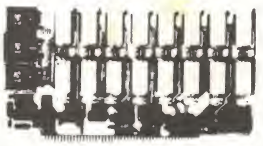
## S100 COMPUTER PRODUCTS

### 16K EPROM CARD-S 100 BUSS



$89.50
KIT

BLANK PC BOARD
$49
USES 2708's!

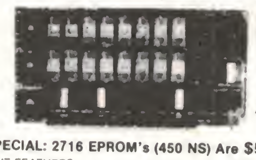
Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at **ALL TIMES!** Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

OUR 450 NS 2708'S ARE $5.90EA. WITH PURCHASE OF KIT

ASSEMBLED AND FULLY TESTED ADD $36

### 32K S-100 EPROM CARD

**NEW!**



**$99.95**

KIT
USES 2716's
Blank PC Board – $59
ASSEMBLED & TESTED
ADD $30

**SPECIAL: 2716 EPROM's (450 NS) Are $5.90 EA. With Above Kit.**

KIT FEATURES
1 Uses +5V only 2716 (2Kx8) EPROM's
2 Allows up to 32K of software on line!
3 IEEE S-100 Compatible
4 Addressable as two independent 16K blocks
5 Cromemco extended or Northstar bank select
6 On board wait state circuitry if needed
7 Any or all EPROM locations can be disabled
8 Double sided PC board solder-masked, silk-screened
9 Gold plated contact fingers
10 Unselected EPROM's automatically powered down for low power
11 Fully buffered and bypassed
12 Easy and quick to assemble

### * * * AVAILABLE AGAIN * * *

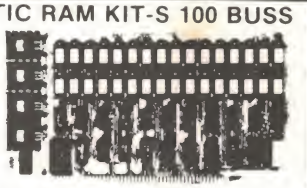
- 16K Dynamic Ram Board
- Fully Expandable to 64K
- Assembled, tested and guaranteed
- S100 Compatible

16K Dynamic RAM Board assembled and tested: Special $269 plus tax (4mHz) $299 plus tax (4mHz) This must be the best offer available on quality tested dynamic RAM boards.

32K Assembled and tested $289 plus tax (4mHz)
48K Assembled and tested $309 plus tax (4mHz)
64K Assembled and tested $329 plus tax (4mHz)

### 16K STATIC RAM KIT-S 100 BUSS

KIT $179
A&T $199



KIT FEATURES
1 Addressable as four separate 4K Blocks
2 ON BOARD BANK SELECT circuitry (Cromemco Standard) Allows up to 512K on line
3 Uses 2114 (450NS) 4K Static Rams
4 ON BOARD SELECTABLE WAIT STATES
5 Double sided PC Board with solder mask and silk screened layout Gold plated contact fingers
6 All address and data lines fully buffered
7 Kit includes ALL parts and sockets
8 PHANTOM is jumpered to PIN 67
9 LOW POWER under 1 5 amps TYPICAL from the +8 Volt Buss
10 Blank PC Board can be populated as any multiple of 4K

BLANK PC BOARD W DATA **$55**
LOW PROFILE SOCKET SET **$22**
SUPPORT IC'S & CAPS **$29**
ASSEMBLED & TESTED **ADD $30**

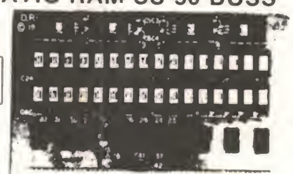
OUR #1 SELLING RAM BOARD!

### 16K STATIC RAM SS-50 BUSS

PRICE CUT!

$199 KIT
A&T $219

FULLY STATIC AT DYNAMIC PRICES



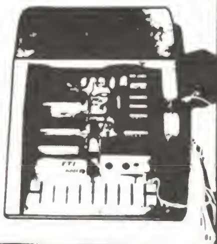
**32K STATIC ALSO AVAILABLE**

KIT FEATURES
1 Addressable on 16K Boundaries
2 Uses 2114 Static Ram
3 Runs at Full Speed
4 Double sided PC Board Solder mask and silk screened layout Gold fingers
5 All Parts and Sockets included
6 Low Power Under 1 5 Amps Typical

FOR SWTPC 6800 BUSS!

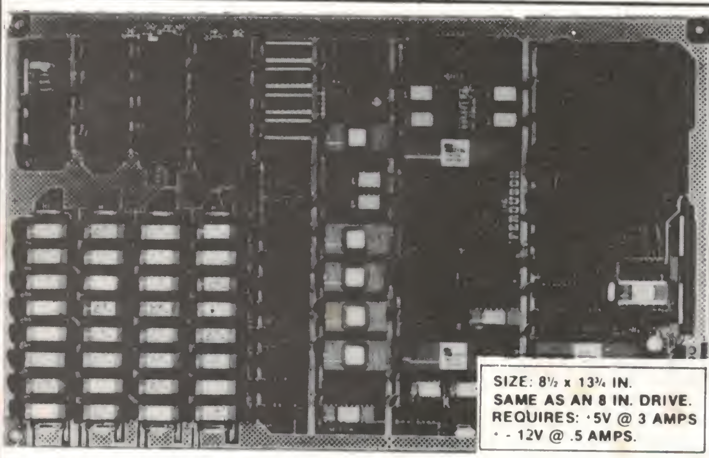
BLANK PC BOARD – $49 COMPLETE SOCKET SET – $22 SUPPORT IC'S AND CAPS – $45

### ETI 660 THE $99 COMPUTER!



FEATURES INCLUDE
Colour capability, operates from optional 9 V plugpack, 1K memory expandable to 3K on-board, single-board construction, cassette interface, audio output, simple to program (uses Chip-8)
Expansion projects coming up include ASCII keyboard, light pen, games software, etc
Starter Kit (1K RAM, B&W Video) $99 00
9 V 1 amp plug pack to suit $12 50
Colour video option $13 50
RAM Expansion (add to PCB) $16 00

**ETI636 7 SLOT MOTHERBOARD WITH ACTIVE TERMINATION**
Kit of Parts $89.00. Assembled and tested $115.00, inc tax.
RITRON COMPUTER GRADE POWER SUPPLY. +5V Reg 10A, ± 16V Unreg. Kit of parts $89.90 inc tax A&T $109.00 inc tax
Write for list of other power supplies. Tax free prices also available.



SIZE: 8½ x 13¾ IN.
SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
± 12V @ .5 AMPS.

# SINGLE BOARD COMPUTER KIT NOW ONLY $499 + TAX (17½%)

Also available: Blank PCB's with Roms **$275** + Tax.
Assembled & Tested **$599** + Tax.

THE FERGUSON PROJECT: Three years in the works, and maybe too good to be true. A tribute to hard headed, no compromise, high performance, American engineering! The Big Board gives you all the most needed computing features on one board at a very reasonable cost. The Big Board was designed from scratch to run the latest version of CP/M*. Just imagine all the off-the-shelf software that can be run on the Big Board without any modifications needed! Take a Big Board, add a couple of 8 inch disc drives, power supply, and an enclosure, and you have a total Business System for about 1/3 the cost you might expect to pay

## FEATURES: (Remember, all this on one board!)

### 64K RAM

Uses Industry standard 4116 RAM'S. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

### Z-80 CPU

Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERUPTS. Fully buffered and runs 8080 software

### 24 x 80 CHARACTER VIDEO

With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true.

### SERIAL I/O (OPTIONAL)

Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232! For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: **$65**

### FLOPPY DISC CONTROLLER

Uses WD1771 controller chip with a TTL Data Separator for enhanced reliability. IBM 3740 compatible. Supports up to four 8 inch disc drives. Directly compatible with standard Shugart drives such as the SA800 or SA801. Drives can be configured for remote AC off-on. Runs CP/M* 2 2.

### BASIC I/O

Consists of a separate parallel port (Z80 PIO) for use with an ASCII encoded keyboard for input. Output would be on the 80 x 24 Video Display.

### FOUR PORT PARALLEL I/O (OPTIONAL)

Uses Z-80 PIO. Full 16 bits, fully buffered, bi-directional. User selectable hand shake polarity. Set of all parts and connectors for parallel I/O: **$29**

### REAL TIME CLOCK (OPTIONAL)

Uses Z-80 CTC. Can be configured as a Counter on Real Time Clock. Set of all parts: **$19**

### PFM 3.0 2K SYSTEM MONITOR

The real power of the Big Board lies in its PFM 3.0 on board monitor. PFM commands include: Dump Memory, Boot CP/M*, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I/O Ports, Disc Read (Drive, Track, Sector), and Search. PFM occupies one of the four 2716 EPROM locations provided. It does not occupy any of the 64K of system RAM!

Bankcard Mail Orders Welcome

Please debit my Bankcard
Bankcard No ____________
Expiry Date ____________
Name ____________
Signature ____________

General enquiries (03) 489-8131. Mail order enquiries (03) 481-1436. Ritronics Wholesale (03) 489-7099. (Tax Exempt Enquiries)

**Prices subject to change without notice. Send 60¢ and SAE for free Price lists. MAIL ORDERS PO BOX 235, NORTHCOTE, Vic. 3070. Minimum pack and post $5.00. Telex AA38897.**

**PLEASE WRITE OR RING FOR THE BEST POSSIBLE PRICES ON DISC DRIVES, PRINTERS AND OTHER COMPUTER COMPONENTS.**

# Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

## ETI-645 Turtle Robot

A complete kit of parts for this project is being offered at a special introductory price by Flexible Systems, and ETI is acting as a clearing house for orders and despatching kits; see page 37 for further details. You can call into our Sydney or Melbourne offices during business hours to see a Tasman Turtle and purchase kits. In Sydney, you'll find us at:

4th Floor, 15 Boundary St,
Rushcutters Bay.

In Melbourne, at:

22nd Floor, 150 Lonsdale St,
Melbourne.

Note that 'Tasman Turtle' is a registered trademark of Flexible Systems.

## ETI-469 Percussion synth.

This project will be widely stocked by kit suppliers. Most components are readily obtainable so constructors should have little difficulty assembling parts. The case we used is Model No. EC.1002 from Sigea in Melbourne. Some kit suppliers have indicated they will have these available. To find your nearest supplier or for further information, contact Sigea at P.O. Box 49, Thornbury Vic. 3071. (03)481-1422.

The knobs we used are a simple 'slip-on' type that fit the standard pot shaft with a 'flat'. They are obtainable with a variety of coloured pointer caps that make for easy identification of the controls — almost essential with this project! Ours were supplied by Jaycar, 125 York St, Sydney. Cost — about 60¢. Collect knobs with colour-coded caps are also ideal for this project, though more expensive.

Scotchcal panels and pc boards are obtainable from the usual suppliers — see page 60 in the March issue.

The 250k linear pots are not usually a 'stock' line, but should be readily obtainable from most component suppliers by the time this issue goes on sale.

**A very handy range of small heatsinks, manufactured by 'Heatsinks Plus' is available from Stewart Electronics, 44 Stafford St, Huntingdale 3166. The range includes types that can be mounted direct on DIL package ICs, TO3 case devices, TO220, TO229 and TO365-6 devices.**

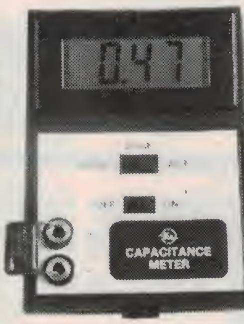
# JAYCAR KITS ➡ QUALITY RESULTS

## DIGITAL CAPACITANCE METER * * *

Ref: EA March 1982
This kit once again uses the amazing DPM 200 LCD display/driver module (see below). Capable of measuring capacitance from 1pF to 19.99uF it is a must in every workshop or lab.

Kit includes case.

**Only $59**




## Digital Thermometer EA2/82

Ref: EA Feb 1982
Read the temperature in your room (or outside) from 0 degrees C to 100 degrees C in fact to within 0.1 degree C. Fantastic resolution on a bright easy-to-read display.

**only $59** INC CASE


## *sensational* LCD Panel Meters


The illustration shows the display with all segments and annunciators actuated. The unit is housed in a neat plastic escutcheon. The DPM measures 72x36mm overall. Digital height — 15mm (can be read at distances up to 10 metres).

Specs:

Input impedance: >100m
Full scale reading: 199.9mV
Accuracy 0.05% of reading ∓1 digit
Power supply: 5-15VDC 50uA
Sample rate: 3/sec
Auto polarity, auto zero, over-range warning

Full data sheet supplied with each unit.

DPM-200 ONLY **$39.50**

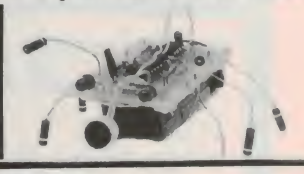
case to suit $5.50

## CUDLIPP CRICKET

Ref: EA Feb 1982

One of the most popular kits ever produced by Jaycar. Cudlipp chirps back to you when you talk. Talk about frustrating! Great fun to hide in someones desk!!
The Jaycar kit comes exclusively with 8 great big colourful 2 watt carbon resistors that you use as legs.
Great fun for only

**$12.50**



## vocal canceller *

Ref: EA April 1982

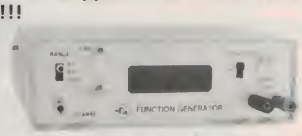
This project enables you to cancel out a singers voice on a record so that you can insert your own.
BE A STAR FOR ONLY **$19.50**

## Function Generator

Ref: EA April 1982

"Pigeon Pair" companion to the new 500MHz DFM. Low distortion generator of sine, square and triangular waveforms. From below 20Hz to over 160kHz. Inbuilt 4 digit frequency counter in de-luxe Pac-Tec case. Only $85
JAYCAR EXCLUSIVE — 1% 50ppm metal film resistors used for stability and it's still only $85!!!

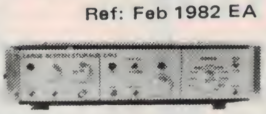
**only $85**



## Digital Storage CRO Adaptor

Ref: Feb 1982 EA

Not only can you avoid buying an expensive CRO but you can have the features of the REALLY expensive ones!!!
— Can display very slow waveforms
— One shot triggering
— Inbuilt graticle shows on TV screen
— Crystal locked timebase
— DC-100kHz bandwidth
— capable of storage operation
Staggering value at $110.

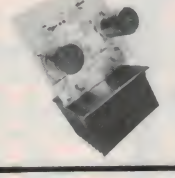


**$110**

## 150W MOSFET AMP KIT *

EXCLUSIVE!!! Special heavy duty EXTRUDED heatsink bracket.

Ref: ETI March 1982



At last high power, with the stability and inherent safety of MOSFETS.
Genuine 150W RMS with power supply on the PCB!! You only need to connect the power trannie and Philips 65D heatsink!!
PF4361/1 transformer $39.50
65D heatsink, drilled, tapped & black anodised $39.50
ETI MODULE ONLY **$79.50**

## SOUND BENDER $34.50

ETI REF: FEB 1982
Jaycar has taken this kit and added a smart all ABS plastic cabinet with specially silk-screened lid. This is the full kit.
If you have a case yourself then the short-form kit is only $24.50!! — includes all parts (less case).

**Jaycar**

!!! NEW ADDRESS !!!
125 YORK ST SYDNEY 2000
Ph. 2646688 Telex 72293

SHOP HOURS
Mon-Fri 9 to 5.30
Sat 9 to 3
Sun 10 to 2
Thurs night to 8pm

Mail Orders To:
Box K-39 Haymarket 2000
Post and Packing charges
$5-$9.99 ($1) $10-$24.99 ($2)
$25-$49.99 ($3) $50-$99.99 ($4)
$100 up ($5.50)

STOP PRESS SPECIAL

# "Budget Busters!"

## NEW TOROIDAL TRANSFORMERS

40V 1.2AMPS

PLUS 15V 200mA

Made in Sweden by TRANSDUKTOR

$21

These high-efficiency Toroidal Transformers are only 80mm diam.x33mm high. Regular price $42.00

## NEW PLESSEY EDGE CONNECTOR

WITH 80xGOLD-PLATED CONTACTS AT 0.156" PITCH, YOU CAN FULFILL ALL YOUR EDGE CONNECTOR NEEDS- YOU CUT THEM TO LENGTH!

ONLY $1

## TRANSFORMERS

MAINS 120V PRIMARY

2 IN SERIES FOR 240V

12V 1A EACH

2 for $2

MAIL ORDERS: ADD $1 EXTRA PER PAIR

## CO-AXIAL SWITCH

SPDT rotary-action switch for HF/VHF use.

$19

by Plessey Ducon Ltd

## CRYSTAL CARTRIDGES

MONO

85c each

STEREO

## STEREO BOOSTERS

REGULAR PRICE $69

NOW YOU SAVE $14

$55

25Wx2

LED BAR-GRAPH POPULAR MODEL

## Save on Hi-Fi SPEAKERS

8 INCH 3 WAY

25 WATT RMS

PAIR ONLY

$89

DON'T PAY UP TO $159 OR MORE FOR 8 INCH 3 WAY SPEAKERS! THESE FACTORY-MADE SPEAKERS ARE IN BEAUTIFUL WALNUT WITH BLACK CLOTH, 8 OHMS

## CAPACITORS "GOING CHEAP"

FULLY G'TEED, TESTED

LOW COST

25,000uF..5v..$2.50
8,000uF.10v..$2.50
50,000uF.12v..$4.00
7,000uF.15v..$3.50
55,000uF.15v..$7.00
5,000uF.20v..$3.50
22,000uF.20v..$7.00
90,000uF.20v..$9.00
10,000uF.25v..$4.00
18,000uF.25v..$6.00
30,000uF.25v..$7.00
48,000uF.25v..$8.00
80,000uF.25v..$9.50
4,000uF.30v..$3.50
19,000uF.30v..$6.00
33,000uF.30v..$7.50
56,000uF.30v..$8.50
3,000uF.75v..$3.00
4,800uF.40v..$3.50
12,000uF.40v..$6.00
3,500uF.45v..$4.00
11,000uF.45v..$6.50
24,000uF.45v..$8.00
46,000uF.45v.$10.50
4,600uF.50v..$6.00
12,400uF.50v..$8.50
5,000uF.63v..$6.50
13,000uF.63v..$9.00
18,000uF.63v.$10.00
5,500uF.75v..$5.00
11,000uF.75v..$8.00
30,000uF.75v.$11.00
2,500uF100v..$3.50
6,800uF100v..$6.00
13,000uF100v.$11.50
2,200uF150v..$5.00
3,500uF150v..$7.50
1,800uF200v..$6.00
4,800uF250v.$11.00
OIL-FILLED PAPER
4uF...660VAC.$3.00
6.5uF...600VAC.$4.00
8uF..330VAC.$4.00
10uF...660VAC.$5.00

## DC MOTORS

6-12V

LARGE SIZE! IDEAL FOR TOYS, MODEL BOATS, CARS, HOBBY ETC. OPERATES FROM 4.5V TO 12V, POWERFULL AND RUGGED, SIZE 47MM DIAM x 60MM

$3 ea

10 for $25

## 10Kgm SURPRISE KIT

LOTS OF HANDY HOBBY-PARTS!

- Motors
- Resistors
- Capacitors
- Semiconductors
- Samples, etc etc.

$9.95 EA

INTER-STATE POST- ADD $3.00

## Tape heads

High quality, low cost REC/PLAY tape heads for replacement in most cassette recorders. Suits Vortex mechanisms, etc.

MONO HEADS also available...$2.99

EA $10

# ASTOUNDING APRIL SAVINGS!

## 12V DC ROTARY SOLENOID STEPPING SWITCH

U.S.A. Made!

$19.99

12 POSITION, SINGLE POLE, SHORTING.

## THE COOLERS

SQUIRREL-CAGE FANS

SINGLE OUTLET

115V OR 220V AC

$14 $20

Very rugged, powerfull, ex-computer blowers.

## DUAL BLOWERS

"BLOW-ME-DOWN" These high-volume coolers are for really heavy-duty use!

$24

115v OR 230v

## CLEARANCE SALE

CB XTALS 27.880, 27.890, 27.900, 27.910..pr$1.50
TTL 7406......10for$2.00
TTL 7420......10for$1.50
TTL 7473......10for$4.00
TTL 7490......10for$4.50
5mm Red LEDS..10for 0.90
5mm Bezel for LED.ea0.05
3AG Fuseholders- in-line plastic......10for$2.00
PCB Fuse-Clips.8for 0.50
Philips 2"8Ω Tweeters 20W power........2 for$4.00
4" Mid-range 8Ω20W power, imported Novik ea.$4.00
6"x4",4"sq. 15Ω..ea.$3.00
Record Cleaner Arm, with cleaning kit...ea.$2.00
12V 100mA mini-globes, wire leads...10for$1.00
Neons NE-2 90v 8for$1.00
DPDT slide switch.ea0.25
DP3T slide switch.ea0.30
DPST rocker " .ea0.30
3 pos 10Amp rotary sw, with white knob..ea0.50
4 pos Oak rotary switch, with On-Off......ea0.50
0.1uF 250v poly 12for $1
0.22uF 100v " 10for $1
0.015uF 200v " 15for $1
0.068uF 400v " 10for $1
0.047uF 200v " 10for $1
0.022uF 200v " 12for $1
0.15uF 250v " 10for $1
0.68uF 250v " 4 for $1
0.056uF 1KV " 3 for $1
0.47uF 400v " 4 for $1
0.1uF ceramic 12for $1
0.047uF ceramic 15for $1
1000pf ceramic 20for $1
100pf 25v styro 20for $1
15uF 35v tantalum ea0.30

## ECONOMY FM MIC

88-108Mhz

Transmits to 50m range, condensor microphone. Normally $14

$10

## IC's

'SWEEPINGS OFF THE FACTORY FLOOR'

Approx 100 ASST. FOR $11.50

1000 for $100

## 12 VOLT SIEMENS CRADLE RELAYS

$2

Double pole on-off contacts normally open

Regular price is over $4.00for this quality!

## MINI RELAYS

EA. $1.49

SPDT 8 TO 15V DC, 225 OHMS, PCB MOUNTING

DPDT 24V, 700 OHMS, 5A CONTAC

240V AC coil HEAVY DUTY 10A CONTACTS 4 CHANGEOVER

Great value, worth over $5 huge purchase enables us to sell for less than HALF! Buy 10+, $2.25

$2.50

Take your pick, great value, limited quantities avail.

## PARTY STROBE

BRAND NEW FACTORY WARRANTY

NORMAL PRICE $29.95 SAVE NEARLY $5.

$25

"Freeze" the action at your next party or theatrical show! Mains operated with a continually variable flash rate, housed in an attractive black vinyl box 150mm

## HEATSINKS

HUGE RANGE AVAILABLE!

3"x4" WITH 1xTO3 TRANS.$2.50
6"x4" WITH 2xTO3 TRANS.$3.00
9"x4" WITH 4xTO3 TRANS.$4.00
3"x4", 3x100PIV 35A RECT. $2

VARIETY PACK- 10 ASSORTED HI-QUALITY HEATSINKS WITH SCR'S, RECTIFIERS AND TRANSISTORS, IDEAL FOR EXPERIMENTERS $9.95

ONLY WHILE THEY LAST! WOW!

## STOP THIEF! Ultra-sonic BURGLAR ALARM

$39

WAS $65, NOW SAVE $16

Ideal for your home, office or shop, the General Electric ultra-sonic alarm is small, self-contained and inconspicuous. The beam detects at up to 30ft, and emits a very loud, shrill tone which can be heard for over 100 metres A 5-digit push-button selector cuts off the alarm which resets after 5 mins, and a 35second test and exit delay and instant "ON" or delay "ON" (10secs) are included.

## SPEAKER BOX SELLOUT! AT PUNCHBOWL

EACH $6

620mm X 350mm X 225mm Deep

Walnut finish, fully assembled, with back panel. No Mail-Order!

## NUMERIC KEYPADS

1 2 3
4 5 6
7 8 9
0 CLR

$2.50

Famous German "Rafi" maker Computer quality switch

11 keys 18x18mm, long life, for PCB mtg.

NEW PACK AND POST CHARGES: BASIC $2.00 PLUS 5% OF ORDER VALUE. We still subsidise many of the orders, as over 500gm postal charges are $3.60 to some states, up to $6.60 over 10Kg. We believe this is a fairer system for all

G.I.S. ELECTRONICS 750-2651

1190 CANTERBURY RD, PUNCHBOWL 2196 NEAR ROSELANDS SHOPPING CENTRE

PRE-PAK electronics

SHOP: 1A WEST ST. LEWISHAM NSW MAIL: P.O. BOX 43, CROYDON NSW 2132

569-9797

Pack/Post: See above.

# LETTERS

**Dear Sir,**

I have been a regular reader of your magazine since it was first published, and have generally preferred your style of presentation to that of your competitors, both here and abroad; however, I have been very disturbed the last few months, by an idiosyncrasy of spelling — namely your use of the double-s in 'buss', which I confess has a similar effect on me to that of hearing car salesmen (and others) talk about 'kill-ommitters'.

The derivation of the word is quite clear-cut — from the Latin 'omnibus' (ablative pl. of omnes) meaning 'for all', applied originally to a horse-drawn vehicle which anybody could ride on for a fee, and later contracted to 'bus' after the motor-omnibus had taken over from the horses. By analogy it was then applied to a heavy conductor, known as a bus-bar, to which large numbers of machines could be connected as a source of power. Later, with the advent of computers, it was used for the much lighter parallel groups of conductors used to carry small signals to various parts of the machine, but still with the same basic concept of being something each device could, as it were, 'jump onto' as necessary.

'Buss' on the other hand is an old word much used by Shakespeare, meaning a kiss — quite a different idea, I'm sure you will agree. To support me in this distinction I would refer you to:

The Concise Oxford Dictionary
The Macquarrie Dictionary
The Random House Dictionary
A Dictionary of Electronics, S. Handel, Penguin
A Dictionary of Computers, A. Chandor et al, Penguin

The only one of the above to give 'buss' as a possible alternative for 'bus' is the Random House (American), and then *only* for its 'meaning 1' (i.e: a motor vehicle).

I had seen very occasional references in advertisements (American) to 'S100 Buss' but had put them down to ignorance, until suddenly, some time in 1981, it dawned on me that you had adopted a policy of using that spelling — either that or your 'Spellguard' had accidentally got misprogrammed! I hope you will tell me the latter is the case, but if it is a new policy I would be interested to hear the reasons, and also whether you have had any other letters of protest? It is apparent that at least some of your contributors prefer the traditional spelling as shown for instance on page 103 of the October issue, where 'BUS' appears on the pc board for the Learner's Microcomputer, ETI-660, although it has been altered to 'buss' in the text of the article!

I was going to remind you how many millions of pounds the British Post Office had saved on printing ink by leaving out the full-stops after 'Rd.', 'St.', etc, in their telephone directories, but after what you have told us about the silver on the November cover that might seem like a fleabite!

**Peter J. Frost**
**Albany W.A.**

P.S. Should you decide to publish this letter, don't forget to disable your Spellguard, or it may not make much sense!

*Thanks for the opening praise, but we just knew it preceded a gripe! Well, I guess we should make some song-and-dance about our 'special' words — buss isn't the only one!*

*For a start, we can dismiss American meanings or interpretations for 'buss'. ETI is not distributed in America (though we do have a few subscribers on the North American continent . . .). We are aware of the meaning of buss as in kiss pertinent to Shakespearean times. To all our 380-year-old readers, we apologise for confusing you . . . There is a more risque meaning, but we won't go into that!*

*We started using the word 'buss' in computer material in ETI during the latter half of 1980. In retrospect, we should have made a 'big deal' of it. The word was adopted in order to distinguish between buses/busses, as much computer material mentioned supply buses and interface/communications busses in juxtaposition without clearly distinguishing which was which. In addition, outside the computer world, the word 'bus' is well understood and generally refers to a supply rail. In computer parlance it usually refers to a group of lines, which generally carry signals. All right, we're out on a limb so far as usage is concerned ( . . . who said 'trendies'?), but the change is partly for our sake as well as readers'.*

*Mind you, 'buss' is not universally accepted amongst staff and correspondents. Graeme Teesdale had his protest engraved forever on the ETI-660 Learners' Microcomputer pc board! (As you noticed.)*

*Secondly, at the risk of disturbing you further, did you spot 'disk' and 'disc', 'program' and 'programme'? In computer material you will see floppy disks and hard disks; in other areas 'disc' is used. When referring to computer software we use 'program', whereas a list or schedule of events, etc, we refer to as a 'programme', as defined by the dictionary.*

*All you Babelo-linguistic critics — stay your quills and rest your tablets as we now bring ETI's Production Editor, Jane Clarke B.A. (Hons.) to the front line. (Only correspondence from Ph.D.s will be accepted . . . not published, just accepted.)*

**R.H.**

Well now, bus or buss is all Greek to me – far too technical – but I couldn't resist pointing out a few quibbles that occurred to me on reading Mr Frost's letter. Firstly, 'omnibus' as translated 'for all' is dative, not ablative, plural; the construction is exactly the same, but if we're splitting hairs . . . As for kilometres, it seems to me they were always pronounced as Mr Frost dislikes until metrication was forced upon us, at which point the Metric Conversion Board stepped in and foisted the inelegant 'killo-meters' onto us. To quote their estimable booklet 'Metric Conversion for Australia' (just what we always wanted): "KILO: Used as a prefix with any unit, the pronunciation should be 'kill-o-' with the accent on the first syllable and 'o' pronounced as in 'oh'. To place the accent on the 'o' or the pronounce the 'o' as in 'tot' is incorrect . . .". Now, with all respect to the Metric Conversion Board and the doubtless logic behind their decree, English has never been a language to succumb well to logic and is best left to find its own level, so to speak, in matters of pronunciation. I for one will stick to 'kill-omitters' (and to 'controversy', however often the ABC offends me with 'c*on*troversy') as the far more elegant form; come to that, if we'd stuck to miles and feet and inches in the first place there'd be no controversy.

Incidentally, we don't have Spellguard on our typesetter; all spelling errors in this magazine are likely to be mine! However, I should like to point out to other readers that the rendition of 'Macquarrie' with double-r in Mr Frost's letter is his own invention entirely, and was left in by us only to show that however erudite, nobody's perfect.

**J.C.**

## ELECTRONIC HOUSEHOLD PROJECTS
Most useful and popular projects for use around the home. Includes two-tone buzzer, intercom, smoke and gas detectors, baby alarm, freezer alarm etc. etc.
**BP71** **$5.90**

## A MICROPROCESSOR PRIMER
This small book takes the mystery out of microprocessors. It starts with a design for a simple computer described in language easy to learn and follow. The shortcomings of this basic machine are then discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions. An interesting and unusual approach.
**BP72** **$5.90**

## REMOTE CONTROL PROJECTS
Covers radio, infra-red, visible light, ultrasonic controls. Full explanations are provided so that the reader can adapt the projects for domestic and industrial as well as model use.
**BP73** **$6.60**

## ELECTRONIC MUSIC PROJECTS
Provides constructors with practical circuits for the less complex music equipment including fuzz box, waa-waa pedal, sustain unit, reverb and phaser, tremolo generator etc. Text covers guitar effects, general effects, sound generators, accessories.
**BP74** **$5.90**

## ELECTRONIC TEST EQUIPMENT CONSTRUCTION
Describes construction of wide range of test gear including FET amplified voltmeter, resistance bridge, field strength indicator, heterodyne frequency meter etc.
**BP75** **$5.90**

## POWER SUPPLY PROJECTS
Designs for many power supplies including simple unstabilised, fixed and variable voltage regulators — particularly for electronics workshops. Also included are cassette power supply, Ni-Cad charger, voltage step-up circuit, and simple inverter, plus info on designing your own supply. All designs are low voltage types for semiconductor circuits.
**BP76** **$5.90**

## PRACTICAL COMPUTER EXPERIMENTS
How to build typical computer circuits using discrete logic. This book is useful intro to devices such as adders and storers as well as a general source book of logic circuits.
**BP78** **$5.90**

## RADIO CONTROL FOR BEGINNERS
How complete systems work with constructional details of solid state transmitters and receivers. Also included — antennas, field strength meter, crystal controlled superhet, electro-mechanical controls. Ideal for beginners. Section dealing with licensing etc. not applicable to Australia.
**BP79** **$5.90**

## POPULAR ELECTRONIC CIRCUITS — BOOK 1
Yet more circuits from Mr Penfold! Includes audio, radio, test gear, music projects, household projects and many more. An extremely useful book for all hobbyists, offering remarkable value for the designs it contains.
**BP80** **$6.60**

## ELECTRONIC SYNTHESISER PROJECTS
For the electronic music enthusiast, an invaluable reference. This book is full of circuits and information on how to build analogue delay lines, sequencers, VCOs, envelope shapers, etc. etc. The author takes a clear and logical approach to the subject that should enable the average enthusiast to understand and build up what appears to be a quite complex instrument.
**BP81** **$5.90**

## ELECTRONIC PROJECTS USING SOLAR CELLS
Well-known author Owen Bishop has designed a number of projects that benefit from solar power and obviate the problems encountered with batteries, such as weight and bulk, frequency of replacement, and failure when batteries are exhausted.
**BP82** **$7.15**

## VMOS PROJECTS
A book to suit the dyed-in-the-wool experimenter. Though primarily concerned with VMOS power FETs and their applications, power MOSFETs are dealt with, too, in a chapter on audio circuits. A number of varied and interesting projects is covered under the headings: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Circuits. Learn while you build.
**BP83** **$6.40**

## DIGITAL IC PROJECTS
Companion to No. 225 Practical Introduction to Digital ICs and BP61 Beginner's Guide to Digital Electronics. The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams are included. The more ambitious projects have been designed to be built and tested section by section to help the constructor avoid or correct any faults that may occur.
**BP84** **$6.40**

## INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
Companion to BP1 and BP14 equivalents books, but contains a huge amount of information on modern transistors produced by over 100 manufacturers. Wherever possible, equivalents are subdivided into European, American and Japanese types. Also shown are the material type, polarity, manufacturer and indication of use or application.
**BP85** **$9.95**

## AN INTRO TO BASIC PROGRAMMING TECHNIQUES
Ideal for beginners seeking to understand and program in BASIC. Book includes program library for biorhythms, graphing Y against X, standard deviations, regressions, generating musical note sequences, and a card game.
**BP86** **$6.60**

## SIMPLE LED CIRCUITS — BOOK 2
Sequel to BP42. Further light-emitting diode circuits. If you liked BP42 you'll love this one. If you don't know either it's well worth buying both!
**BP87** **$5.05**

## ELECTRONIC CIRCUITS FOR MODEL RAILWAYS
Constructional details of a simple model train controller, a controller with simulated inertia, a high-power controller, an electronic steam whistle and a 'chuff generator'. Signal systems and train lighting and RF suppression also covered.
**BP95 (was 213)** **$3.40**

# ORDER FORM

**Send to ETI Book Sales, 4th Floor, 15 Boundary St, Rushcutters Bay NSW 2011.**
**Please allow 4-5 weeks for delivery. Trade enquiries welcomed.**

**Please forward:**

Post & Handling: 1 — 4 books: $1.35; 5 — 10 books: $2.70; 11 — 20 books: $3.50; Over 20 books: $5.00

| Book | Qty. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
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| 205 | ...... | 226 | ...... | BP59 | ...... | BP72 | ...... | BP83 | ...... |
| 211 | ...... | 227 | ...... | BP61 | ...... | BP73 | ...... | BP84 | ...... |
| 214 | ...... | BP2 | ...... | BP62 | ...... | BP74 | ...... | BP85 | ...... |
| 218 | ...... | BP23 | ...... | BP63 | ...... | BP75 | ...... | BP86 | ...... |
| 219 | ...... | BP27 | ...... | BP64 | ...... | BP76 | ...... | BP87 | ...... |
| 220 | ...... | BP44 | ...... | BP65 | ...... | BP77 | ...... | BP89 | ...... |
| 221 | ...... | BP47 | ...... | BP66 | ...... | BP78 | ...... | BP95 (was 213) | ...... |
| 222 | ...... | BP48 | ...... | BP67 | ...... | BP79 | ...... | | |
| 223 | ...... | BP50 | ...... | BP68 | ...... | BP80 | ...... | | |

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# New interface from H-P increases HP-41 power, versatility

A new interface system introduced to Australia by Hewlett-Packard enables a conventional handheld calculator to 'talk' with and control measurement instruments and other devices. The interface also provides the calculator with a mass memory capability, and the ability to communicate directly with a computer.

**John Deftereos, Hewlett-Packard Area Manager for Personal Computing Products, says the new interface has numerous applications in business, science and engineering.**

"We call it the HP-IL," Mr Deftereos explains, which stands for Hewlett-Packard Interface Loop.

"In effect, the HP-IL turns an HP-41 (Hewlett-Packard's top of the range handheld calculator) into a portable computer system. The calculator becomes a general purpose controller capable of transmitting and receiving data, and performing a wide variety of control functions."

The HP-IL module, which simply plugs into the calculator, enables the calculator to interface with a series of peripherals and measurement devices to form portable computational and information systems. These are suitable for use in the field, or in bench and desktop configurations.

Communication between HP-41 calculators and Hewlett-Packard Series 80 personal computers is now possible with the HP-IL. This capability opens up many possibilities, such as collecting customer data in the field with an HP-41, then dumping, analysing and storing the data in the personal computer, and reloading it in the calculator.

Simultaneous with HP-IL release, Hewlett-Packard is introducing a number of instruments and peripherals for use with HP-41 calculators.

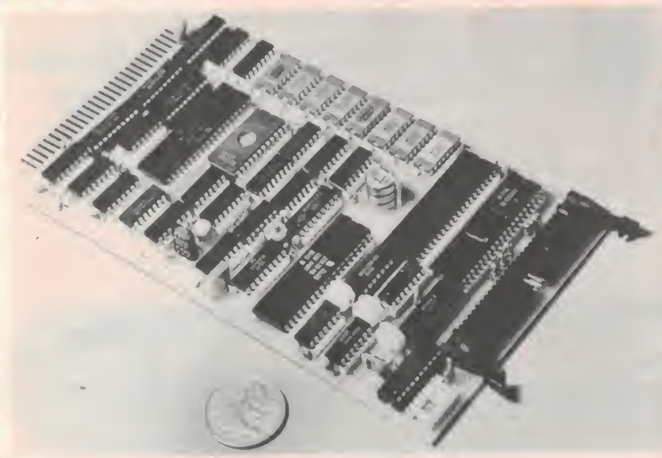
These include a digital cassette drive providing 131K of on-line mass storage — 50 times the memory of an HP-41 calculator, and a thermal printer/plotter which can produce hard copy data, bar codes and graphics. Both these peripherals are battery-powered and controlled by the calculator via the HP-IL.

A new five-function multimeter controlled by an HP-41 calculator can perform a range of measurement tasks. An HP-IL converter is a component designed to be built into other devices, such as measurement instruments. It connects the internal electronics of the machine to the HP-IL loop, allowing the machine to communicate with other devices on the loop and with the HP-41 controller.

"Hewlett-Packard is putting all its experience with interfaces into making HP-IL a high-quality, versatile interface," Mr Deftereos says.

"Our commitment to HP-IL means that many Hewlett-Packard divisions in the calculator, instrument and computer areas will be introducing HP-IL devices. For example, many of our future handheld calculators and personal computers will support HP-IL. HP-IL also gives users great flexibility to expand and change the system according to their needs."

For further information contact Hewlett-Packard Australia Ltd, 31-41 Joseph Street, Blackburn, Victoria. (03)89-6351. Branches in Adelaide, Perth, Brisbane, Canberra, and Sydney (02)887-1611; also in Auckland and Wellington, New Zealand.



## The 'little big board'

**Pulsar Electronics has released a 'little big board' computer designed for industrial control users, business applications and the enthusiast; it measures just 115 x 200 mm.**

It features a Z80A CPU running at 4 MHz, 64K of RAM on board, two serial (RS232C) input/output ports, 5" or 8" disk interface for double and/or single density, double-sided disks, a battery backed-up real time clock and calendar and an STD buss configuration.

The new board is available configured as follows:

- Assembled and tested with monitor program, with or without a power supply.
- In a Hazeltime terminal, i.e: as a 64K intelligent terminal.
- With two double-sided, double density 8" floppy disk drives (2.5M of mass storage).
- As a complete terminal, with two disk drives and CP/M 2.2 installed.

Further information is available from Pulsar Electronics, 323 Bell St, Pascoe Vale Vic. 3044. (03)354-2125.

QT COMPUTER SYSTEMS (AUST.) **S-100 SPECIALISTS** 283 CLARENCE ST SYDNEY NSW 2000 TEL: 29-2402

# ARE YOU STILL WAITING??

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While others are promising we are delivering EX STOCK. And we still have the best prices. Just take a look at these:

## RAM + 16

Features: S-100, 16K x 8 bit static RAM • 2 or 4 MHz • Uses 2114 1K x 4 static RAM chip • 4K step addressable • 1K increment memory protection, from bottom board address up or top down • Deactivates up to 6 1K board segments to create "holes" for other devices • DIP switch selectable wait states • Phantom line DIP switch • Eight bank select lines expandable to ½ million byte system • Data, address and control lines all input buffered • Ignores I/O commands at board address.

| | |
|---|---|
| Bare Board | $ 35.00 |
| 4Mhz kit | $174.00 |
| 4Mhz A&T | $199.00 |
| Kit no RAM | $120.00 |

## DYNAMIC RAM

T.I. 4116-3 16K for $16.00

Upgrade Super 80, TRS 80, and others

Expandable + 64K. S100 )

Dynamic RAM Board A&T ) $325.00

Guaranteed to work at 4Mhz or your money back

## QT SILENCE+MOTHERBOARDS

The Silence + has become one of the most tried and proven motherboards on the market. Using a unique grounding matrix, each line is completely surrounded with ground shielding which eliminates necissity for termination and gives the unit a very high cross talk rejection. One of the OEM customers has used the Silence + as high as 14Mhz without terminations.

FEATURES:

- LED power indicator
- Eliminates necessity for termination
- Fits most industry standard mainframes
- Available in 6, 8, 12 and 18 slot configurations

| | | |
|---|---|---|
| QTCMB6BB | 6 Slot Bare Board | $ 31.00 |
| QTCMB6A | 6 Slot A&T | $ 81.00 |
| QTCMB8BB | 8 Slot Bare Board | $ 33.00 |
| QTCMB8A | 8 Slot A&T | $104.00 |
| QTCMB12BB | 12 Slot Bare Board | $ 39.00 |
| QTCMB12A | 12 Slot A&B | $138.00 |
| QTCMB18BB | 18 Slot Bare Board | $ 61.00 |
| QTCMB18A | 18 Slot A&T | $178.00 |
| S100 Sockets | Solder Tail (Gold) | $ 6.30 |

## SBC2/4 Z80 S100 SINGLE BOARD COMPUTER

The QT Computer SBC2/4 Processor Board is a versatile and powerful Z80 based design which is compatible with the proposed IEEE S-100 bus standard. Although the SBC2/4 may be used as the host CPU of a large system, it has all the necessary features to be used as a stand-alone computer system.

Unlike old designs it will work reliably with dynamic RAM boards and more importantly with soft sectored disk controllers, and hence standard versions of CP/M. This will give you access to the largest software base for microcomputers.

- Z80A 8 bit CPU
- 2 or 4 Mhz Switch selectable
- 1K RAM (which can be located at any 1K boundary
- Full 64K use of RAM allowed in shadow mode
- DMA compatability allows MWRT signal generation on CPU board or elsewhere in system under DMA logic or front panel control
- TWO programmable timers available for use by programs run with the SBC+2/4 (timer output and controls available for use on CPU board).

Shipping weight: 2lbs.

| | | |
|---|---|---|
| QTCSBC24B | Bare Board | $ 66.00 |
| QTCSBC24K | Kit | $199.00 |
| QTCSBC24A | Assembled and Tested | $269.00 |

## MF + MD MAINFRAME

The MD+MD Mainframe offers the same quality as the MF+. It accepts two 5 1/4" disk drives with remaining space for either a 6, 8, or 12 slot Silence Plus Motherboard.

| | | |
|---|---|---|
| QTCMFMD | without Motherboard | $400.00 |
| QTCMFMD6 | with 6 Slot Motherboard | $480.00 |
| QTCMFMD8 | with 8 Slot Motherboard | $500.00 |
| QTCMFMD12 | with 12 Slot Motherboard | $540.00 |
| QTCMFMDB | bare metal work | $175.00 |

Also available without cutouts on front panel

## DISK CONTROLLER

CCS2422A features ROM bootstrap loader and monitor • CP/M 2.2 with ducumentation included • Accepts 5 1/4" and 8" disk drives • Double sided/single sided select • Read, write IBM 3740 or system 34 single or double density • Fast seek available for voice coil operation • Automatic disk density determination • ROM bootstrap phantom.

| | |
|---|---|
| CCS2422A A & T Incl. CP/M 2.2 | $399.95 |
| JADE DD Bare Board | $ 85.00 |
| QTFDC II A&T Incl. QT DOS | $379.00 |
| Disk Drive cables made to order | P.O.A. |

## SYSTEM + II (2MB +)

Computer system with 8" Dual Sided Drives (uses Y-E DATA YD174 Disk Drives) Terminal not included.

| | |
|---|---|
| A&T (6 Slot) | $3883.00 |
| A&T (8 slot) | $4083.00 |

## MINI-SYSTEM + (½MB +)

Computer System with 5 1/4" Single Sided Drives (uses TEAC FD-50A Disk Drives) Terminal not included.

| | |
|---|---|
| A&T (6 slot) | $3048.00 |
| A&T (8 slot) | $3073.00 |

QT Systems are designed for both businessmen and engineers in accordance with the latest IEEE standards. Among other functions, they can be used for accounting and word processing as well as a variety of scientific applications. The systems are available with MP/M or QT DOS operating systems to allow multi-user, multi-tasking operations. QT also offers a full line of business and applications software, ranging from a business package to word processing.

Technical specifications. 4 MHz Z-80 CPU • Dbl-sided, dbl-den 5 1/4" or 8" floppy disk controller (handles both drives simultaneously) • CP/M 2.2 included • 64K RAM, expandable per your requirements • Comes complete in single mainframe • RS232C serial port • Parallel port • Hard disk compatible • Monitor program & disk routines included on EPROM • Power-on/reset jump to monitor program • Documentation included • Extensive software available.

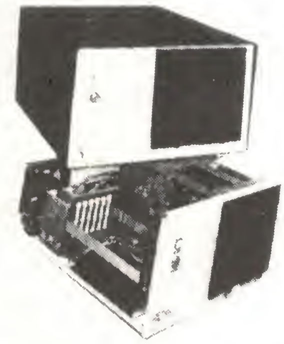
## SOFTWARE +

Word processing • System utilities and diagnostics • Games • CP/M users group diskettes $10.00 each, catalogue $6.00 • Pascall, Forth, Tarbell Basic, Fortran and most other compilers and utilities are available • Complete range of business software • Custom programming can be arranged on a fixed price or hourly basis.

PRICES DO NOT INCLUDE SALES TAX OR DELIVERY, AND ARE SUBJECT TO CHANGE WITHOUT NOTICE •

## MAINFRAMES

S-100 MAINFRAME FOR DUAL 8" DISK DRIVES



AT LAST! A desk top enclosure that will accommodate a S-100 bus system and two 8" disk drives. The MF+MD mainframe is the most versatile dual 8" mainframe on the market. It will accommodate 6, 8, or 12 slot card cages using the Silence + motherboards. Just add a CPU, memory board, disk controller and terminal and you have an inexpensive, high quality computer system.

FEATURES;

- Accommodates and 8" standard disk drive (801R, DT-8, etc.)
- IEEE S-100 Silence + 6, 8 or 12 slot motherboard available. (See motherboard description at left.)
- Keyed power switch.
- Reset switch on front panel.
- Anodized 6, 8 or 12 slot cages.
- Quiet fan provides cool system operation featuring filtered positive air pressure. User may add two additional fans for the 12 slot if required.
- Detachable line chord plugs directly into EMI filter for electrical noise suppression.
- 16 DB25 cut out
- 2 50 pin plug connector cut outs.
- 2 DD55 cut outs.
- Dimensions 9 5/8" x 17" x 21" (HxWxD)
- Power supply +8V@25A/+- 16V @ 5A/ +5@2.5A/-5@5A/+24V@3A
- Input Voltage 110-113VAC/220-240VAC 50-60 Hz 48 lbs.

| | | |
|---|---|---|
| QTCMFDD | without Motherboard | $575.00 |
| QTCMFDD6 | with 6 Slot Motherboard | $625.00 |
| QTCMFDD8 | with 8 Slot Motherboard | $650.00 |
| QTZMFDD12 | with 12 slot Motherboard | $700.00 |
| QTCB | Bare Metalwork | $175.00 |

## PERIPHERALS +

We have fantastic specials on printers, terminals, plotters and disk drives. Call or write for details and pricing. Here are some examples:

YD-174 8" DS/DD Drives @ $625.00

2 for $1200.00

VIEWPIONT Terminal 80x24 detachable keyboard $995.00

Hazeltine Esprit 80 x 24

Green Screen. Emulates other terminals.

Optional Graphics. Best value $975.00

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TEAC and MPI mini drives, 40 or 80 track.

Single or double sided. Our prices are too low to advertise!! We carry a complete range of cabinets and power supplies for 5 1/4" and 8" drives for single and dual drives.

ITOH DAISYWHEEL 25 cps (parallel) $1500.00

Serial or 40 cps optional.

ITOH M8510 Graphics Printer

Parallel version (serial optional) $ 795.00

LIMITED STOCKS

64K static RAM Intermix RAM and EPROM 200 nano. Very low power.

Kit No RAM $149

256K S-100 Dynamic Ram LIMITED STOCKS!!

- Full IEEE 696
- Assembled and tested, with 64K or 256K

CR256-64 $795.00

CR256-256 $995.00

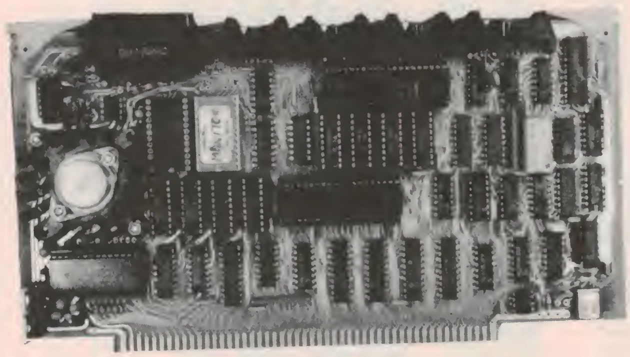
PLACE YOUR BANCKARD ORDERS BY PHONE!! WE DELIVER OVERNIGHT ANYWHERE IN AUST. FOR $3.50 up to 4kg. Or $10 up to 10kg.

WE HAVE A COMPLETE RANGE OF S100 BOARDS AND MICROCOMPUTER PRODUCTS IF THE PRODUCT YOU REQUIRE IS NOT ADVERTISED DUE TO LACK OF SPACE PLEASE CALL OR WRITE.

OUR 1982 CATALOGUE IS NOW AVAILABLE. SEND S.A.E. FOR FREE COPY!!

# GBUG — powerful monitor for 2650 microcomputer systems

A powerful new monitor for 2650-based microcomputer systems has been developed by local programmer Laurie Gellatly.



**It supersedes the widely used PIPBUG and BINBUG 2650 monitors and features:**

- Screen editing while using character input routine with corrected line passed back
- Edit mode constantly identified by blinking cursor
- Extra and extended commands
- Fast, controlled, flicker-free scrolling

GBUG is a 1.5K monitor which can either be stored totally in ROM or 1K of ROM + 0.5K RAM. The 1K of ROM is located at 0000 HEX; the remainder is located at 5800 HEX (although any location could be used). An ETI-640 memory-mapped VDU is the initial output device. The monitor will write down the screen and scroll when it reaches the bottom line. Serial input is at 300 Baud (600 Baud for 2 MHz clock) and 2650A-1 microprocessor via the sense pin, while serial output is via the flag pin at the same rate.

GBUG is claimed to correctly handle CR, LF, BS (BACK SPACE), FF (FORM FEED) and HT (HORIZONTAL TAB) keyboard commands. Ctrl U and Ctrl D are used for entry to the edit mode. Other control characters are ignored by CHIN/COUT subroutines (CHaracter INput/CHaracter OUTput).

The following commands are employed:

**A:** Alter/Inspect memory. Syntax **Ammmm.** Starting at location mmmm outputs the location then the hex value thereat. If a new value is typed in then the last two hex characters replace the old value. Leading zeros need not be entered. If no new value is entered the contents are unaltered. An LF will move on to the next address. A CR terminates this command.

**B:** Breakpoint setup. Syntax **Bmmmm.** Replaces location mmmm and mmmm+1 by an instruction to branch to a save register routine and stop. When the processor encounters a breakpoint it saves its registers and prints out the breakpoint location. Because all registers are saved, when the breakpoint is encountered the user can then inspect the registers and resume execution. This feature allows a program to be examined in sections.

**C:** Clear breakpoint. Syntax **C.** Clears breakpoint by replacing data to its original location and displaying the address that was cleared. If no breakpoint has been set a '?' error results.

**D:** Dump/DOS. Syntax **Dssss eeee gggg.** Dump to serial media or go to Disk Operating System. 'Dump' serially outputs the information from memory location ssss to eeee in a format suitable for storage on tape and later loading via the load routine. If gggg is supplied, then after loading a branch to that address is performed.

**ssss** = start address
**eeee** = end address
**gggg** = optional go address

If D alone is entered then a branch to DOS is performed.

**F:** Freeze top lines of screen. Syntax **Fx.** Will freeze from scrolling or clearing the top x hex lines; x can be any hex number from 0 to F. If x is omitted, 0 is assumed.

**G:** Go to address. Syntax **Gmmmm.** All registers are loaded from any previously stored values (either via a Breakpoint or set via the 'S' command) and a branch to address mmmm is performed.

**L:** Loads from serial media. Syntax **L.** Loads memory from a serial device.

**P:** Printer echo On/Off. Syntax **Px.** Will send serial characters to a printer and to the screen. x can be any hex number 0 to FF. if x›0 then this feature is invoked. If x = 0 or is omitted then characters are only printed on the screen. This uses the extended output feature.

**Q.** Quick Scroll. Syntax **Qx.** As the second K of the ETI-640 is usually unchanged the processor would do unnecessary work shifting this when scrolling is required. When used, this command only scrolls the first K of screen. This halves the time to scroll the screen.

**S:** See and set registers. Syntax **Sx.** Any value from 0-8 can be used for x, which selects the first register to be examined. The register contents are displayed and are altered as with the 'A' command. Responding with an LF moves on to the next register except after the eighth, where a '?' error results. Response of a CR terminates the command. Note that these values are given to the appropriate registers upon a 'G' command. This command is also used to inspect the registers after a breakpoint has been encountered.

**V:** VDU Scroll control. Syntax **Vx.** Will stop the screen every 15 lines and wait for a key to be pressed before continuing.

A number of extra control characters are decoded. These are:

**TAB:** When an HT (Ctrl I;09 hex) is output via the COUT subroutine the cursor will move to the next horizontal tab position to the right of the current cursor position.

**FORM FEED:** When an FF (Ctrl L;0C hex) is output via COUT all non-frozen lines on the screen will ▶

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|---|---|---|
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| SD7 | 7 | 2.40 |
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| | 1-9 | 10-25 |
|---|---|---|
| 8 Pin | 1.00 | .90 |
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| 16 Pin | 1.20 | 1.70 |
| 18 Pin | 1.50 | 1.40 |
| 20 Pin | 1.80 | 1.60 |
| 22 Pin | 1.90 | 1.70 |
| 24 Pin | 2.00 | 1.80 |
| 28 Pin | 2.20 | 2.10 |
| 36 Pin | 2.60 | 2.40 |
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| | 1-9 | 10+ |
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**CMOS**

| | |
|---|---|
| 4000 | .40 |
| 4001A | .40 |
| 4001B | .40 |
| 4002 | .50 |
| 4006 | 1.10 |
| 4007 | .50 |
| 4008 | 1.00 |
| 4009 | .80 |
| 4010 | .50 |
| 4011 | .40 |
| 4012 | .50 |
| 4013 | .80 |
| 4014 | 1.70 |
| 4015 | .90 |
| 4016 | .70 |
| 4017 | 1.50 |
| 4018 | 1.50 |
| 4019 | .60 |
| 4020 | 1.20 |
| 4021 | 1.10 |
| 4022 | 1.05 |
| 4023 | .70 |
| 4024 | 1.00 |
| 4025 | .50 |
| 4026 | 2.20 |
| 4027 | .60 |
| 4028 | .90 |
| 4029 | 1.20 |
| 4030 | .60 |
| 4031 | 2.20 |
| 4034 | 3.00 |
| 4035 | 1.30 |
| 4039 | .70 |
| 4040 | 1.70 |
| 4041 | 1.05 |
| 4042 | .70 |
| 4043 | .70 |
| 4044 | .70 |
| 4046 | 1.20 |
| 4047 | 1.20 |
| 4048 | .60 |
| 4049 | .60 |
| 4050 | .60 |
| 4051 | 1.00 |
| 4052 | .80 |
| 4053 | .80 |
| 4060 | 2.00 |
| 4066 | .80 |
| 4068 | .60 |
| 4069 | .70 |
| 4070 | .50 |
| 4071 | .60 |
| 4072 | .50 |
| 4073 | .60 |
| 4075 | .60 |
| 4076 | 1.20 |
| 4077 | .50 |
| 4078 | .60 |
| 4081 | .60 |
| 4082 | .60 |
| 4089 | 1.00 |
| 4093 | .80 |
| 4503 | .60 |
| 4510 | 1.50 |
| 4511 | 1.50 |
| 4512 | 1.10 |
| 4514 | 2.50 |
| 4516 | 1.40 |
| 4518 | 1.50 |
| 4519 | .55 |
| 4520 | 1.60 |
| 4522 | 1.25 |
| 4527 | 1.20 |
| 4528 | 1.25 |
| 4529 | 1.60 |
| 4539 | 1.60 |
| 4541 | 1.60 |
| 4543 | 2.00 |
| 4553 | 5.50 |
| 4555 | 1.00 |
| 40097 | .95 |
| 40098 | .95 |
| 40175 | 1.00 |
| **74C SERIES** | |
| 74C100 | .40 |
| 74C02 | .40 |
| 74C04 | .40 |
| 74C08 | .40 |
| 74C10 | .40 |
| 74C14 | .90 |
| 74C20 | .40 |
| 74C30 | .40 |
| 74C32 | .40 |
| 74C42 | 1.10 |
| 74C48 | 1.55 |
| 74C73 | .75 |
| 74C74 | .70 |
| 74C76 | .75 |
| 74C83 | 1.40 |
| 74C85 | 1.20 |
| 74C86 | .80 |
| 74C90 | .80 |
| 74C93 | 1.40 |
| 74C95 | .95 |
| 74C107 | .70 |
| 74C150 | 3.40 |
| 74C151 | 1.00 |
| 74C160 | .90 |
| 74C192 | .90 |
| 74C164 | 1.10 |
| 74C173 | 1.00 |
| 74C174 | .80 |
| 74C175 | 1.00 |
| 74C192 | 1.20 |
| 74C195 | 1.00 |
| 74C221 | 1.90 |
| 74C373 | 1.80 |
| 74C374 | 2.00 |
| 74C901 | .90 |
| 74C902 | .90 |
| 74C905 | 11.20 |
| 74C906 | .80 |
| 74C907 | .80 |
| 74C915 | 1.50 |
| 74C922 | 3.80 |
| 74C923 | 5.00 |
| 74C925 | 7.50 |
| 74C926 | 7.50 |
| 74C927 | 5.90 |
| 74C932 | 5.50 |
| **80C SERIES** | |
| MM80C95 | .90 |
| 80C96 | .90 |
| MM80297 | .90 |
| 80C98 | .90 |
| **LINEAR** | |
| LH0002 | 9.50 |
| LH0022CD | 16.60 |
| LH0042CH | 8.60 |
| LH0070 | 12.70 |
| LH0071 | 12.70 |
| TL071 | 1.00 |
| TL072 | 1.50 |
| TL082 | 1.50 |
| SAK140 | 2.20 |
| UAA170 | 3.50 |
| UAA180 | 3.50 |
| TCA220 | 2.20 |
| LM301 | .50 |
| LM301-H | .50 |
| LM304-H | 1.70 |
| LM305-H | .80 |
| LM307-CN | .40 |
| LM307-H | .90 |
| LM308 | .70 |
| LM308-H | 1.20 |
| LM310-N | 2.20 |
| LM310-H | 2.60 |
| 311 | .60 |
| LM311 | .60 |
| LM311-H | 1.20 |
| LM318 | 2.80 |
| LM322 | 3.90 |
| LM324 | 1.20 |
| LM325 | 3.10 |
| LM329-DZ | 1.40 |
| LM334-Z | 1.30 |
| LM335 | 12.40 |
| LM336-Z | 3.20 |
| LM339 | .90 |
| LM348 | 1.10 |
| LM349 | 1.80 |
| LF351-N | .70 |
| LF356-AN | 1.10 |
| LF357 | 1.10 |
| LM358 | .70 |
| LM373 | 4.10 |
| LM374 | 5.40 |
| LM376 | .70 |
| LM377 | 2.90 |
| LM379 | 5.70 |
| LM308 8PIN | 1.30 |
| LM380 14PIN | 1.50 |
| LM318A-N | 2.40 |
| LM318N | 1.80 |
| LM382N | 2.00 |
| LM383 | 2.70 |
| LM384 | 2.40 |
| LM386 | 1.00 |
| LM387 | 1.30 |
| LM391 | 1.80 |
| LM393 | .80 |
| LF398 | 5.00 |
| 8038 | 6.00 |
| NE530 | 1.10 |
| OM350 | 9.90 |
| 555 | .40 |
| 556 | 1.10 |
| LM565 | 1.30 |
| LM565CH | 2.00 |
| NE566 | 2.50 |
| LM567 | 1.50 |
| NE571 | 6.50 |
| LM709 14PIN | .70 |
| UA710CA | .60 |
| LM710-CH | .90 |
| 711 | .80 |
| UA711-H | .85 |
| UA716HC | 6.25 |
| 723 | .50 |
| LM723CH | 1.10 |
| LM725 | 3.90 |
| LM733 | 1.20 |
| UA739 | 2.00 |
| 741 | .25 |
| LM741-H | 1.20 |
| UA747 | 1.00 |
| UA747HC | 2.20 |
| UA748 | .50 |
| UA748HC | 1.25 |
| UA753 | 1.80 |
| UA760HC | 4.10 |
| UA777 | 2.40 |
| UA777HC | 2.65 |
| 9334 | 1.70 |
| UA743 | 1.80 |
| UA760HC | 4.10 |
| UA796HC | 1.70 |
| LM802 | 1.10 |
| LM1310N | 2.40 |
| 1408 | 4.90 |
| LM1458 | .60 |
| UA1488 | 1.50 |
| UA1489 | 1.50 |
| MC1495 | 7.30 |
| MC1496L | 11.40 |
| LM1558 | 1.50 |
| LM1596 | 1.40 |
| LM1380 | 3.10 |
| LM2902 | 1.40 |
| LM2917 8PIN | 2.80 |
| LM2917 | 3.10 |
| CA3028 | 1.80 |
| LM3039 | .90 |
| CA3046 | 1.70 |
| 3065 | .45 |
| LM3080 | 1.20 |
| LM3089 | 3.90 |
| CA3130T | 1.40 |
| CA3130E | 1.80 |
| CA3140 | 1.40 |
| 3401 | .70 |
| 3611 | 1.10 |
| LM3900 | .90 |
| LM3909 | 1.00 |
| LM3914N | 3.90 |
| 4136 | 1.40 |
| LM4250 | 1.75 |
| UA4558TC | 1.40 |
| MM5837 | 2.50 |
| LM7555 | 1.80 |
| Mc10116L | .95 |
| LF13741 | .60 |
| LF1374-1H | .70 |
| DS75452 | .60 |
| 76477 | 4.90 |
| 75451 | .60 |
| 75491 | 1.40 |
| 75492 | 1.40 |
| **TTL (s)** | |
| 74S00 | .80 |
| 74S02 | .80 |
| 74S04 | .80 |
| 74S10 | .75 |
| 74S11 | .75 |
| 74S32 | .75 |
| 75S51 | .75 |
| 74S74 | 1.20 |
| 74S86 | 1.40 |
| 74S112 | 1.20 |
| 74S135 | 2.20 |
| 74S138 | 3.20 |
| 74S157 | 2.95 |
| 74S158 | 2.95 |
| 74S182 | 3.30 |
| **7400 SERIES** | |
| 7400 | .40 |
| 7401 | .40 |
| 7402 | .40 |
| 7403 | .40 |
| 7404 | .40 |
| 7405 | .50 |
| 7406 | .50 |
| 7407 | .50 |
| 7408 | .40 |
| 7409 | .40 |
| 7410 | .40 |
| 7411 | .40 |
| 7412 | .40 |
| 7413 | .50 |
| 7414 | .70 |
| 7416 | .50 |
| 7417 | .60 |
| 7420 | .40 |
| 7421 | .40 |
| 7423 | .50 |
| 7425 | .45 |
| 7426 | .40 |
| 7427 | .40 |
| 7430 | .40 |
| 7432 | .40 |
| 7437 | .40 |
| 7438 | .50 |
| 7440 | .50 |
| 7441 | 1.00 |
| 7442 | .50 |
| 7443 | 1.40 |
| 7444 | 1.20 |
| 7445 | 1.10 |
| 7446 | 1.00 |
| 7447 | 1.00 |
| 7448 | 1.00 |
| 7450 | .50 |
| 7451 | .50 |
| 7453 | .40 |
| 8T26 | 2.20 |
| 9300 | .60 |
| 9307 | 1.80 |
| 9308 | 1.20 |
| 7454 | .60 |
| 7472 | .60 |
| 7473 | .60 |
| 7474 | .60 |
| 7475 | .60 |
| 7476 | .60 |
| 7480 | .65 |
| 7482 | 1.80 |
| 7483 | .80 |
| 7485 | .80 |
| 7486 | .60 |
| 7489 | 2.60 |
| 7490 | .70 |
| 7491 | .55 |
| 7492 | .60 |
| 7493 | .60 |
| 7494 | .90 |
| 7495 | .45 |
| 7496 | .80 |
| 7497 | 2.50 |
| 74107 | .80 |
| 74109 | .60 |
| 74116 | 2.20 |
| 74121 | .45 |
| 74122 | .65 |
| 74123 | .60 |
| 74125 | .55 |
| 74126 | .60 |
| 74132 | .80 |
| 74141 | 1.10 |
| 74145 | .85 |
| 74147 | 2.00 |
| 74148 | 1.40 |
| 74150 | 1.20 |
| 74151 | .60 |
| 74152 | 4.90 |
| 74153 | .70 |
| 74154 | 1.20 |
| 74155 | .90 |
| 8T28 | 3.00 |
| 9310 | .65 |
| 9311 | 1.00 |
| 9312 | 1.35 |
| 74156 | 1.50 |
| 74157 | .60 |
| 74161 | 1.00 |
| 74162 | 1.00 |
| 74163 | .85 |
| 74164 | .60 |
| 74165 | .60 |
| 74174 | .50 |
| 74175 | .90 |
| 74176 | 1.10 |
| 74177 | 1.10 |
| 74180 | .90 |
| 74181 | 2.30 |
| 74182 | .90 |
| 74184 | 3.75 |
| 74185 | 1.20 |
| 74190 | 1.00 |
| 74191 | 1.50 |
| 74192 | 1.70 |
| 74193 | .80 |
| 74194 | 1.10 |
| 74195 | .65 |
| 74196 | .85 |
| 74197 | 1.10 |
| 74198 | 1.10 |
| 74199 | 1.30 |
| 74221 | .90 |
| 74290 | .90 |
| 73293 | .90 |
| 74365 | .80 |
| 74366 | .80 |
| 74367 | 1.00 |
| 74368 | 1.00 |
| 8T96 | 1.80 |
| 9314 | 1.30 |
| 9368 | 1.75 |
| 9370 | 2.00 |
| **74LS SERIES** | |
| 74LS00 | .40 |
| 74LS01 | .40 |
| 74LS02 | .40 |
| 74LS03 | .40 |
| 74LS05 | .40 |
| 74LS08 | .40 |
| 74LS09 | .40 |
| 74LS10 | .40 |
| 74LS11 | .40 |
| 74LS13 | .50 |
| 74LS14 | .90 |
| 74LS15 | .40 |
| 74LS20 | .40 |
| 74LS21 | .40 |
| 74LS22 | .40 |
| 74LS26 | .40 |
| 74LS28 | .40 |
| 74LS30 | .40 |
| 74LS32 | .40 |
| 74LS33 | .40 |
| 74LS37 | .50 |
| 74LS38 | .50 |
| 74LS40 | .50 |
| 74LS42 | .75 |
| 74LS47 | .85 |
| 74LS48 | 1.00 |
| 74LS49 | 1.00 |
| 74LS51 | .40 |
| 74LS54 | .50 |
| 74LS55 | .55 |
| 74LS58 | .65 |
| 74LS73 | .55 |
| 74LS74 | .60 |
| 74LS75 | .45 |
| 74LS76 | .50 |
| 74LS78 | .50 |
| 74LS83 | 1.00 |
| 74LS85 | 1.00 |
| 74LS86 | .50 |
| 74LS90 | .70 |
| 74LS92 | .90 |
| 74LS93 | .80 |
| 74LS95 | .65 |
| 74LS96 | 1.55 |
| 74LS107 | .60 |
| 74LS109 | .60 |
| 74LS112 | .60 |
| 74LS113 | .65 |
| 74LS114 | .50 |
| 74LS122 | .50 |
| 74LS123 | .75 |
| 74LS125 | .50 |
| 74LS126 | .70 |
| 74LS132 | .80 |
| 74LS133 | .50 |
| 74LS136 | .50 |
| 74LS138 | 1.20 |
| 74LS139 | .85 |
| 74LS151 | .75 |
| 74LS153 | .60 |
| 74LS154 | 1.50 |
| 74LS155 | 1.00 |
| 74LS156 | 1.00 |
| 74LS157 | .90 |
| 74LS158 | .70 |
| 74LS160 | .85 |
| 74LS161 | .85 |
| 74LS162 | 1.00 |
| 74LS163 | .85 |
| 74LS164 | 1.30 |
| 74LS165 | .90 |
| 74LS168 | 1.90 |
| 74LS169 | 1.90 |
| 74LS170 | 2.80 |
| 74LS173 | .90 |
| 74LS174 | .90 |
| 74LS175 | .90 |
| 74LS181 | 2.50 |
| 74LS189 | 3.80 |
| 74LS190 | 1.30 |
| 74LS191 | 1.30 |
| 74LS192 | .85 |
| 74LS193 | .85 |
| 74LS194 | .70 |
| 74LS195 | .80 |
| 74LS196 | 1.25 |
| 74LS197 | 1.00 |
| 74LS221 | 1.10 |
| 74LS245 | 2.35 |
| 74LS247 | .90 |
| 74LS249 | 1.30 |
| 74LS251 | .80 |
| 74LS253 | .90 |
| 74LS257 | .65 |
| 74LS258 | .50 |
| 74LS259 | 2.45 |
| 74LS260 | .90 |
| 74LS266 | .90 |
| 74LS273 | 1.60 |
| 74LS279 | .65 |
| 74LS283 | 1.15 |
| 74LS290 | 1.10 |
| 74LS293 | 1.15 |
| 74LS295 | 1.60 |
| 74LS298 | 1.00 |
| 74LS352 | 1.30 |
| 74LS353 | 1.30 |
| 74LS365 | .50 |
| 74LS366 | .70 |
| 74LS367 | .90 |
| 74LS368 | .90 |
| 74LS373 | 1.50 |
| 74LS374 | 1.70 |
| 74LS386 | .50 |
| 74LS670 | 2.70 |
| 81LS95 | 2.10 |
| 95H90 | 11.50 |
| 11C90 | 19.50 |
| 81LS96 | 2.10 |
| 81LS97 | 2.10 |
| **TRANSISTORS** | |
| 2N301 | 2.20 |
| 2N657 | .60 |
| 2N930 | .60 |
| 2N1613 | 1.10 |
| 2N1711 | .50 |
| 2N1893 | 1.00 |
| 2N2219A | .60 |
| PN2222 | .20 |
| PN2222 | .30 |
| 2N2463 | .35 |
| 2N2484 | .65 |
| 2N2646 | .70 |
| 2N2647 | 1.10 |
| 2N2894 | .80 |
| 2N2904 | .45 |
| 2N2905 | .40 |
| 2N2906 | .45 |
| 2N2913 | 1.20 |
| PN2907 | .30 |
| 2N3053 | .60 |
| 2N3054 | .90 |
| 2N3055 | .90 |
| 2N3301 | .40 |
| 2N3440 | 1.10 |
| 2N3502 | .70 |
| 2N3503 | .70 |
| 2N3563 | .30 |
| 2N3564 | .30 |
| 2N3569 | .30 |
| PN3565 | .30 |
| PN3566 | .30 |
| PN3567 | .30 |
| 2N3568 | .30 |
| 2N3638 | .30 |
| 2N3639 | .30 |
| 2N3640 | .30 |
| 2N3641 | .30 |
| 2N3645 | .30 |
| PN3642 | .30 |
| PN3643 | .30 |
| PN3644 | .30 |
| 2N3646 | .30 |
| 2N3692 | .50 |
| 2N3693 | .35 |
| 2N3702 | .30 |
| PN3694 | .30 |
| 2N3704 | .30 |
| 2N3709 | .30 |
| 2N3713 | 2.20 |
| 2N3819 | .80 |
| 2N3866 | 2.00 |
| 2N3904 | .30 |
| 2N3906 | .30 |
| 2N4030 | 1.10 |
| 2N4032 | .55 |
| 2N4033 | .90 |
| 2N4036 | 1.00 |
| 2N4037 | .90 |
| PN4121 | .30 |
| 2N4233 | 1.60 |
| 2N4235 | 1.90 |
| 2N4236 | 2.20 |
| 2N4248 | .30 |
| PN4249 | .30 |
| 2N4250 | .30 |
| 2N4258 | .30 |
| 2N4292 | .70 |
| 2N4354 | .30 |
| 2N4355 | .30 |
| 2N4356 | .30 |
| 2N4398 | 5.00 |
| 2N4401 | .50 |
| 2N4402 | .50 |
| 2N4403 | .50 |
| 2N4416 | 1.00 |
| 2N4906 | 2.80 |
| PN4868 | .30 |
| 2N5088 | .30 |
| 2N5089 | .30 |
| 2N5179 | 1.90 |
| 2N5303 | 3.30 |
| 2N5320 | .80 |
| 2N5401 | .30 |
| 2N5458 | .70 |
| 2N5459 | .70 |
| 2N5461 | .70 |
| 2N5484 | .70 |
| 2N5485 | .70 |
| 2N5486 | .70 |
| 2N5769 | .30 |
| 2N5770 | .25 |
| 2N5830 | .25 |
| 2N5831 | .30 |
| 2N5856 | .30 |
| 2N5873 | 1.10 |
| 2N5874 | 1.40 |
| 2N5961 | .30 |
| 2N5963 | 1.10 |
| 2N6027 | .60 |
| 3N201 | .90 |
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| AC128 | .70 |
| AC187 | .70 |
| AC188 | .70 |
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| AD161 | 1.70 |
| AD162 | 1.70 |
| BC318 | .30 |
| BC319 | .18 |
| BC327 | .15 |
| BC328 | .30 |
| BC337 | .30 |
| BC338 | .30 |
| BC547 | .15 |
| BC548 | .15 |
| BC549 | .15 |
| BC549C | .40 |
| BC557 | .16 |
| BC558 | .16 |
| BC559 | .16 |
| BC637 | .25 |
| BC638 | .36 |
| BC639 | .80 |
| BC640 | .80 |
| BCY70 | .85 |
| BCY71 | .85 |
| BD115 | 1.50 |
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| BD139 | .70 |
| BD140 | .70 |
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| BD234 | .50 |
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## Sharp handheld with advanced design features

**A new handheld personal computer system which incorporates features and memory capability previously unavailable in a machine of its size was recently announced at the Las Vegas Winter Consumer Electronics Show by Richard Brayden, General Manager of Sharp Electronics Corporation's Systems Division in the US.**

The new computer, model PC-1500, features a 7 x 156 programmable dot matrix liquid crystal display, an extended BASIC language operating system capable of handling two-dimensional arrays, variable string lengths, program chaining, full graphic commands and many other functions.

The PC-1500 has 16K of system ROM and 2.6K (expandable to 6.6K) of user-available RAM. The unit can also generate a full upper and lower case ASCII character set, as well as providing user-definable function keys for rapid programming and operation.

The PC-1500's optional printer provides four-colour graphic capability, nine different character sizes, bi-directional line feed and x, y plotting capability. The printer also incorporates a dual cassette interface for program and data storage/ retrieval.


be cleared and the cursor will appear in the upper left corner of the cleared area.

Editing allows any routine calling the CHIN subroutine to edit any line on the screen and have that edited line passed back to the calling routine. Several commands are available in the edit mode to move and replace the characters on the line.

The edit mode is entered by either a Ctrl U (which also moves the cursor up) or a Ctrl D (which also moves the cursor down). At this instant and until either a CR or LF is entered the user is in edit mode (signified by a blinking cursor).

We can't cover it all here, but if you have a 2650-based micro, the ETI-685 S100 board for example, then full details are available from Laurie Gellatly, 8th Floor, Carlton House, 55 Elizabeth St, Sydney. (02)232-6366.

## Low power Z80

**Zilog has announced a family of low-power versions of the Z80 micro, called the Z80L, said to rival CMOS micros, such as National's NSC800, with its low current operation and low cost.**

The Z80L is claimed to be very well suited to battery back-up applications, and is being offered in three different speed ranges: 1 MHz, 1.5 MHz and 2.5 MHz.

The devices operate over a temperature range of 0-70°C and will be available in either plastic or ceramic packs. The CPU, SIO, CTC and PIO will be offered in the 'L' version but the DMA will not. The current consumption of a 1 MHz Z80L (ZL8400PS) is 15 mA at 25°C.

Production quantities will become available progressively through 1982 via the Zilog distributor, George Brown Electronics Group. (George Brown & Co, Browntronics and Protronics).

# Printout

## Computer interface for Olivettis

**Inca Data Systems has available STOL communications interfaces which provide RS232C facilities enabling Olivetti Model ET221 electronic typewriters to be connected as letter-quality printers to such microcomputers as Apple, Tandy, National Panasonic, Durango, Zenith and Hewlett-Packard. The advantage is of course that the ET221 may be used as a stand-alone typewriter when not printing.**

Through logical, two-character commands the operator of the host computer may call up many of the print features of the Olivetti ET221, such as proportional spacing, decimal tabulation, automatic centring, reverse image and automatic underlining.

The STOL interface also enables the ET221 to act as an interactive terminal. As a demonstration, Inca connected a STOL/ET221 to the Source database in the USA by means of the Midas communications facility, made a number of on-line enquiries and stored the data for future recall. With the pending introduction of an Australian Source data network the STOL/ET221 combination could provide all the necessary terminal functions plus letter-quality printing.

The STOL interface is available now for immediate delivery, and may be fitted to both new Olivetti ET221s or to units already in use. Inca provides service on a national basis.

For further information contact Mike McLaren, Inca Data Systems Pty Ltd, 2nd Floor, 10 Help St, Chatswood NSW 2067. (02)411-7844.

## CHIP-8 intelligence — how to get it

**ETI-660 owners will be interested to know that a Melbourne software supplier has a range of CHIP-8 programs available that really show what the language can do.**

'Dreamcards', as this business is called, claim that their software moves away from the traditional graphics orientation of most CHIP-8 programs to feature high-order intelligence.

Their present range comprises three software packages: 'Rummy' and 'Strip Jack Naked' (2K; $15 for cassette and instructions), 'Pontoon' (4K — $25 for cassette and instructions), and 'The Professor' (a 2K maths teaching program for children - $17.50 for cassette and instructions).

The Software was originally written for the 'Dream 6800' computer, so a few minor modifications are required to allow it to run on the ETI-660 because of its extra 'tone' and 'colour' features. 'Dreamcards' tell us that they are happy to assist anyone who has problems with this, but say that the high quality and considerable detail of their material should make difficulties unlikely.

If you have built the ETI-660 you will find these programs contain a wealth of information on how to get the best out of CHIP-8. For further information contact Lindsay Ford of 'Dreamcards', 8 Highland Court, Eltham North Vic. 3095. (03)439-4467 (ah).

## Short computer graphics course at NSW Uni

**The University of New South Wales will be conducting two special week-long intensive short courses on 'Elements of Computer Graphics'. The course will be of interest to mechanical, industrial, electrical, civil or aeronautical engineers involved in design work.**

Computer graphics has become an essential element in solving the complex design and analysis tasks which face engineers each day. The course aims to build on their basic knowledge of computer graphics and develop their understanding of the concepts involved.

The course is interactive and will involve 'hands on' problem solving using Tektronix computer graphics systems, as well as a complete series of seminars conducted by Dr. David F. Rogers. Dr. Rogers is Professor of Aerospace Engineering at the US Naval Academy and he developed its computer-aided design/interactive graphics facility. He has taught courses in CAD/CAM and interactive graphics for many years.

Attendance will be limited, and intending participants are advised to book early.

Course times will be as follows:

- Course #1: Monday July 5 — Friday July 9 1982 (9 am — 5 pm)
- Course #2: Monday July 12 — Friday July 16 1982 (9 am — 5 pm).

For further information contact Associate Professor R.D. Archer, School of Mechanical and Industrial Engineering, University of New South Wales, Kensington NSW 2033. (02)662-3720.


# Disks, CP / M and your computer

Disks aren't just super-fast cassettes — they change the whole personality of your computer. It's also important to know a bit about a disk operating system, like CP/M, **before** you buy.

**Graham Wideman**

BY THIS TIME in history, it's possible that anyone the slightest bit interested in buying a personal computer is already familiar with how a computer can be programmed in BASIC, and how programs and data can be stored on cassettes. However, there seems to be a barrier of mystery surrounding the matter of disks and disk operating systems, tending to make the beginning computer enthusiast regard them as subjects of advanced study, to be taken on far in the future. At best, disk systems are looked upon as an extension of what the inexperienced already understands, in other words as 'super-cassette' storage devices.

This state of affairs is a great shame, since it far underestimates the true worth of a disk-augmented computer system, and in addition precludes the computer purchaser from making the best possible decisions. This article aims to clear away some of this mystery, and to give a philosophical feel for what a disk means to a computer system.

## A shift of emphasis

There is an understandable feeling among users of simple cassette-based computer systems that the object of the user's attention is the 'program'. This program can be written, debugged and run, and then saved on cassette, later to be loaded and run again. If data is generated by the program, it is usually displayed immediately on the screen, or may with varying degrees of difficulty be saved on the cassette. This data is almost looked upon as a nuisance if it must be saved for later, such as in a cheque-book balancing program.

In a computer system with disks the emphasis changes radically. The centre of attention is now an entity known as a 'file'. A file is a bunch of data which spends most of its time stored on the disk (this data actually might be a program, or text, or numbers). A typical activity involves first loading from disk a file which is a program. This program automatically starts, and is used as a tool to operate upon other files on the same or other disks. By 'operate on' I mean that the file is loaded in, the program does something to it, and then at the end of a session the changed file is put back on the disk.

As a specific example, suppose file 1 is a program which conveniently allows text to be entered from the keyboard or disk, and gives a pretty display on the screen. It might also allow the text to be modified with great ease. In short, a word processor program. File 2 might be a story that has been half finished by the author.

A session might proceed as follows. Author loads file 1. File 1, being a program, starts to execute, asking questions of the author. Author gives the responses that indicate he wants to work on the story contained in file 2. So the word processor program loads file 2 into memory, displays the desired portion of it, and for the rest of the afternoon the author uses the word processor as a tool to modify and add to the text. Ultimately, he gives the command to save the modified text on the disk. Now file 2 contains the modified text. Later, if the author is satisfied with the text he can load file 3, which we shall say is a program whose purpose is to take the text in a file and send it to a printer. The file 3 program is asked by the author to print out file 2. And so on.

Again, the emphasis is very much on the file as the centre of attention. Almost every operation that is performed by the operator involves getting files off or putting files onto the disk, with some processing in between. This shift of emphasis is hardly surprising given the vastly increased speed and reliability of the disk storage mechanism over the cassette. And it is an orientation suited to work; you start with something (or even nothing), you do some work on it, and then you save it.

## Disk operating systems

If your computer has no disks, then the 'personality' which talks to you is the power-on-monitor, or BASIC. Whichever one it is there are certain words your computer talks to you with, and words you can use to talk to it. In BASIC you can say things like LIST or RUN or start entering lines of program. A computer with disks must have a new personality, one which allows you to interact with the disks. In this personality you are typically equipped with words which allow you to select a specific disk drive (if there is more than one), to get a readout of the contents of the disk inserted in that drive, to load a file, and so on. This personality is called the 'disk operating system' — the system by which the disks are operated.

In fact what has really happened is that your computer is now a whole new machine. Although disk operating systems or 'DOSs' are not the most straightforward subjects, and tend to have rather cryptic words, the study of one of the most popular will prove to be of great use when shopping, or developing your knowledge of computers. On then to look at CP/M.

## What's CP/M

CP/M, standing for 'Control Program/Micro' (so what?), was developed by Digital Research Corp., principally for use with the Intel MDS 800 system, which you've probably never heard of. However, a lot of people liked the way it worked and adopted it for their computer products, so now it's really widespread. In any case, let's see what it does for your machine.

Two major aspects of CP/M are important to discuss. The first is the personality it gives your computer, the things it allows you to do, the ways it lets you talk to your computer and disks. The second is the fact that with CP/M your computer becomes a 'standard' CP/M computer, not only in the way it interfaces to you (the words you use) but in the way other programs you might buy or trade act with your computer. If your bought or traded program has to output to the screen, it sends its characters to CP/M, which, having been set up for your machine, knows how to send characters to your screen.

## CP/M's personality

The first thing that any good operating system should do is to allow you to call files by name. In other words you shouldn't have to locate data or programs by specifying what track and sector they are stored at. You shouldn't even have to know their length. So CP/M allows you to name files with a two-part name like FRED.TXT. CP/M keeps track of where the file FRED.TXT is on the disk, using a list called the 'directory.' The part of the name preceding the period can be up to eight letters, numbers or symbols, and the part after up to three. By convention, the first part of the name is called the 'filename,' and the second part is known as the 'filetype', 'extension' or 'typ', although only in a few cases is the filetype of any special significance.

CP/M has several built-in commands. These include DIR, which you would type if you want a listing of the directory, so you know what's on that disk; ERA to erase a file; REN which allows you to rename a file, and a few others.

Most of the exciting work takes place if you load a program. If you name a program file with the extension 'COM', then CP/M recognises the filename as a command. In other words, if I called my word processor file 'WP. COM,' later I can type 'WP' and CP/M will get WP.COM off the disk, and immediately start running that program. Such non-built-in commands (which you and I think of as programs) are termed in CP/M 'transient commands' because they are not always in memory, just when you ask for them.

CP/M comes with an assortment of such transient commands or programs, a program for copying files, a rudimentary (very) editor, an 8080 assembler and various necessary utilities.

> ### MP/M
>
> MP/M is an operating system somewhat similar to CP/M (and in fact fully compatible with CP/M). The difference is that it allows more than one user to access the system *at the same time*.
>
> This doesn't only mean more than one person using a machine — it means that even a single user can speed throughput by, for example, 'spooling' printout. This means that while you are printing one file you can be doing something else at the same time.
>
> Not only does MP/M allow multi-user support, it can also be given tasks to perform at particular times (MP/M is 'aware' of the time). This means that, in large systems, a program can be entered *once* which will 'back up' all system files at three in the morning every morning, without operator intervention.
>
> MP/M is really the last link in the chain — it holds almost all the features that up to now have separated domestic computers from 'mainframes'.

## Some work with CP/M

As an exercise in familiarisation with working with disks, let's suppose we want to write a machine language program using the assembler. For the sake of the example the 'program' will be extremely simple, just a jump to location 0 in memory.

First we decided on a name for the assembly language text file ... say EXAMPLE.ASM (the .ASM typ is necessary, as we shall see). So now we type:

```
ED EXAMPLE.ASM
```

This calls the program ED (file ED.COM) and hands over to it the name EXAMPLE.ASM as the name of the file to be worked on. (I'm omitting the computer's prompts and simplifying somewhat, just to give the flavour of what's happening.) Then ED allows us to enter with its peculiar (very) commands the following text:

```
ORG 100H
JMP 0
END
```

Next we tell ED we're through, and ED stores the text with the file name EXAMPLE.ASM. On to assemble this program. We type:

```
ASM EXAMPLE
```

The program ASM (file ASM.COM) comes off the disk and executes, looking for the file EXAMPLE.ASM (must be '.ASM' or ASM won't work on it). Soon the screen tells us that ASM is through, and we can proceed. ASM has created another file, called EXAMPLE.HEX wherein are contained the op-codes specified by our assembly language

program. They are stored in what is called Intel Hex Format, which amongst other things stores both the bytes themselves and the addresses where they are supposed to go in memory. In this case we specified with the ORG 100H statement that the program was to originate (start) at location 100H, and this information is incorporated in the HEX file. The final step is to make an executable program file from this HEX file, for which we use the program LOAD:

LOAD EXAMPLE

This causes LOAD to come into memory, then bring in EXAMPLE.HEX (must be '.HEX' or LOAD won't work on it) and then LOAD makes a new file, EXAMPLE.COM, containing the actual raw machine code. Now if we type EXAMPLE, CP/M will get the file EXAMPLE.COM off the disk, and start to execute it, which of course won't be very exciting, since it's just a jump to 0H. But at least this shows how work is done.

## Inside CP/M

We've just seen how CP/M allows you to work with your disk-computer system. But this is only the superficial half of the story. Let's look at the inside.

CP/M is a large program, or rather a large collection of routines. These you might imagine to have a 'central core', which dictates the procedures involved in CP/M operations. This is termed the BDOS or Basic Disk Operating System, and is the same for all CP/M programs (of the same version number) regardless of the computer they are running on. This BDOS interacts with the disk drives through a collection of routines which I'll call the Disk Input/Output System, or DIOS. This must of course attend to the details peculiar to the particular disk drives to be interfaced. As a consequence, you don't usually buy CP/M by itself, you buy it with the drives. The drive manufacturer will have contributed the DIOS routines.

But CP/M still has to talk to your computer's facilities, such as its screen and keyboard, or terminal, printer and possibly cassettes. The group of routines that take care of these functions are called the CBIOS, or Console Basic I/O System. If you are lucky, when you buy the drives, the manufacturer will have already written the appropriate routines for your computer; if not you'll have to write them, a somewhat tedious procedure since your keyboard and screen can't talk to CP/M until they are done. (So if you don't feel up to the task, check first!)

There are two other groups of routines that you'll encounter. The first is the last section of CP/M itself, the CCP or Console Command Processor, which takes care of the procedures involved in the built-in commands you can give from the keyboard, such as the DIRectory listing. The other set of routines are those contained in the 'boot ROM'. Included with a CP/M disk package is a Read Only Memory, which is addressed at some otherwise unused spot in your computer's memory. It contains the routines to initially start loading routines from the disk after you turn on your computer. In order to start up your disks after turning on your machine, you 'escape' to the power-on monitor, and then order a jump to whatever the address of the ROM. The computer then follows the routines in the ROM which initialise the disk drives and then load a more sophisticated loader program, which then brings in the rest of the CP/M program collection and puts it in the appropriate area of your computer's memory.

## The virtues of being standard

Since the central core of the CP/M program is common to all CP/M computers, all such outfits appear to the user to work the same way. The details of each computer are taken care of by routines which do not affect the interaction with the user. But perhaps more importantly, CP/M makes all CP/M computers look the same to programs which may be run, greatly facilitating the exchange of programs and data, widening the selection available to you. In order to do this, CP/M enforces or assumes certain requirements and conventions on the way things must be.

First there's the obvious one that CP/M is written in 8080 machine code, so only computers with 8080, 8085, or Z80 microprocessors will run it. This includes the Exidy Sorcerer, TRS-80 and Dick Smith System 80, most S100 computers, and even the Apple if equipped with the accessory Z-80 card, not to mention assorted other popular personal computers.

Secondly, CP/M uses some parts of memory for itself, and assumes that the user's programs will be in a particular location. Specifically, the CP/M program sits in the top approximately 8K of RAM. The bottom 'page' (0 to OFFH) is used for housekeeping, remembering facts about the disks and files that are being accessed and so on. The user's programs (.COM files) are assumed to start at 100H, so that CP/M knows where to load them, and where to jump to, to automatically start execution.

The features which allow programs to use CP/M are the 'entry address' and calling conventions. If the user's program needs something done, whether it's output to the screen, input from keyboard, or interaction with the disks, a certain set procedure is used. The user program loads a specific function code into the microprocessor's register C, and further parameters into registers D and E, and then does a CALL 0005H. Address 5 is already set up by CP/M as a jump to the CP/M program, which then looks at the information in registers C, D and E, and carries out the functions requested. Finally, control is returned to the user's program, and information if any from CP/M is passed again in registers D and E (this might be actual input from a keyboard, or a code indicating that a disk read was successful, etc.

Since all these conventions have been established, any program which follows these conventions can use your CP/M computer.

## How standard is it?

If CP/M will run on your computer, you are virtually assured that any CP/M-based software will run successfully with it (some software does have special requirements, like certain minimum memory size). However, getting that software into your computer can be a different matter. There *is* a 'standard' CP/M disk format, which is 8" single-density 128 bytes per sector. However, this format is relatively unpopular with personal computer owners, who tend to prefer the 5.25" disk size, which is used with many different density and sectoring formats. As a consequence some software vendors are offering CP/M software in up to *fifty* different formats. If you are buying a 5.25" drive then it would be wise to see that the store has some kind of facility to copy software from 8" disks down to yours. Otherwise your software buying will be confined to those dealers who can afford to offer many formats, including yours. Folding an 8" floppy so you get it in the door of your 5.25" drive just won't do. (If you find somebody with the same computer and 8" drives, you can of course get the software into your machine via cassette, or serial port, so you won't be totally lost.)

## CP/M or what?

CP/M is not the only operating system around, and certainly not the ultimate state of achievement. However, it is representative of operating systems you might encounter for a personal computer. The major attribute it has going for it is that there is a lot of software written for it. This in turn has made CP/M yet more widely used, and this popularity is likely to continue for some while, with newer releases of CP/M more appropriate for the market that has seized it. So if you are in the market for disk drives, or even a complete computer system, it is worth considering whether you'll have access to this vast and growing selection of software. ●

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MicroBee has been developed as the finest instructional computer on the market. Its superb 16K BASIC in ROM makes this possible. Whether you are a novice or advanced enthusiast, MicroWorld BASIC is a delight to use, with its advanced error reporting and powerful graphics facilities.

```
06000 REM This subroutine draws a square of lengths l1,l2
06005 REM with the bottom corner at a1,b1
06010 VAR(A1,B1,L1,L2)
06020 REM Draw left side, then top, then right, then bottom
06030 GOSUB [ A1,B1,A1,B1+L2 ] 4000
06040 GOSUB [ A1,B1+L2,A1+L1,B1+L2 ] 4000
06050 GOSUB [ A1+L1,B1+L2,A1+L1,B1 ] 4000
06060 GOSUB [ A1+L1,B1,A1,B1 ] 4000
06999 RETURN
65000 END
```

```
Portions of lines may also be underlined for another effect,

e.g. This procedure must be followed at all times.

or in case of special notation ...

  r = a cos(w) + b sin(w)

The verb in this sentence is swam
```

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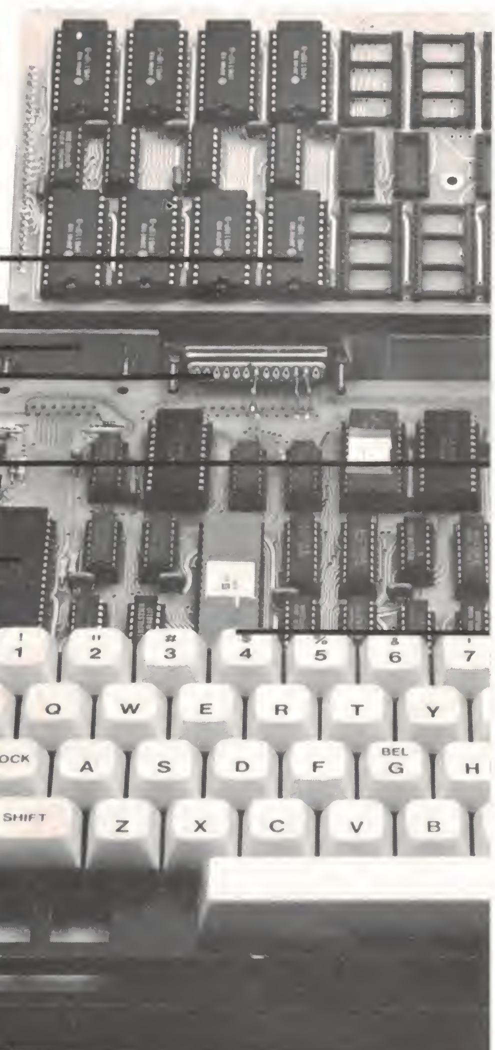

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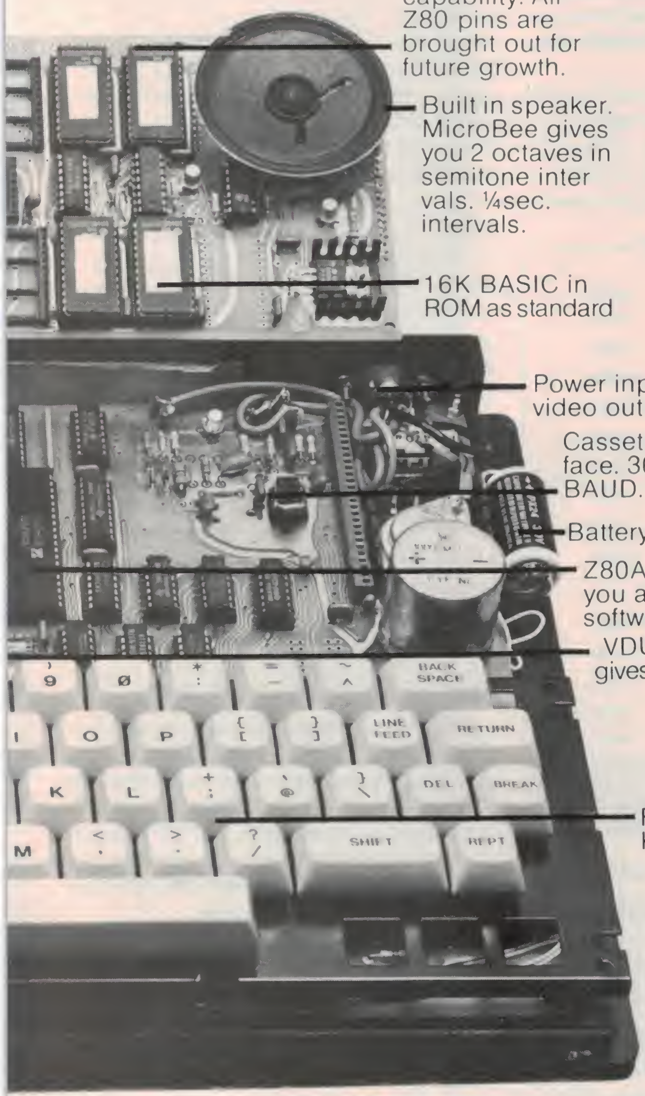


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# How to score!

Here's a handy little software routine and two useful examples employing it. The article describes how to display a variable on the screen as two decimal digits — useful for scoring and other things.

**Phil Cohen**

THIS HANDY little number takes the value in the VD variable and puts it onto the screen as a two-digit decimal number. The top left position of the left-hand digit is set by variables VB and VC.

I've used this routine in two programs so far — the Reaction Timer and the Clock — and I'll probably use it again later.

Its usefulness stems from the fact that it's not too basic (for example, it automatically updates the value of VB so that the next thing you put on the screen is to the right of the numbers) but at the same time it's not too complex (I didn't include zero suppression, for example).

Choosing the level of complexity of a general-purpose routine is not easy (especially when you don't know what programs you're going to use it in), but you should give some thought to it.

The routine uses the V0, V1 and V2 variables and also the memory locations 0700 to 0702 — so the program that uses it should not make use of them.

It works like this: 0704 I=0700 sets the special-purpose I variable to the spare area at 0700. Then the useful M(I)=DECML VD statement takes the value in VD, translates it into a decimal number between 0 and 255 (which does all the work), and puts it in the memory locations starting at I (0700).

Statement 0708 takes the memory contents starting at I and puts them into variables V0, V1 and V2 — so V0 now holds the 'hundreds' digit, V1 the 'tens' and V2 the 'units'.

Now, for the reasons outlined above (about the complexity of general-purpose routines), I've limited this routine to two decimal digits (0 to 99), and so the 'hundreds' digit is not used. This means that if VD is over 99 (decimal), funny things will start to happen (try it and see).

All that remains now is to put the digits representing V1 and V2 on the screen. This is done using the useful I=DISPLY V1 function, which sets the value of the I variable so that it points to the area of ROM memory which holds the screen representation of the number in V1.

All that remains is to display the five bytes that are found at that location, and this is done by a SHOW 5 @ VB, VC.

The value of VB (which gives the horizontal position on the screen) is then updated by statement 0710 before the second digit is put on the screen.

The value of VB is increased *again* at the end of the routine, so that the main program doesn't have to worry about moving the position of its next output to take into account the fact that there are two digits on the screen it doesn't want to overwrite.

The example given simply sets up VB, VC and VD with reasonable values and calls the routine by means of the DO 0704 statement. This sends CHIP-8 to location 0704, where the routine starts.

**TWO-DIGIT PRINT**

```
0704  I=0700              A700
   6  M(I)=DECML VD       FD33
   8  V0:V2=M(I)          F265
   A  I= DSPLY V1         F129
   C  SHOW 5 @ VB, VC     DBC5
   E  I=DSPLY V2          F229
0710  VB=VB+05            7B05
   2  SHOW 5 @ VB, VC     DBC5
   4  VB=VB+05            7B05
   6  RETURN              00EE

EXAMPLE:
0600  VB=10               6B10
   2  VC=10               6C10
   3  VD=63               6D63
   4  DO 0704             2704
   6  MONITOR             0000
```

**Routine to print the value of VD as a two-digit decimal number at location VB, VC. VB is incremented. V0, V1 and V2 are used by this routine. 0700 to 0702 are reserved for use by this routine.**

When the routine is finished, the 00EE command at the end of it sends it back to the location after the one it was called from (in this case, it would go back to 0606).

At 0606, the calling program has a 0000, which transfers control back to the monitor program, and the effect is the same as pressing RESET.

## Reaction Timer program

This little program is not only fun — it also shows the use of the 'two-digit print' routine.

If you're going to use this program, enter all the bytes shown here, and then also enter the two-digit print routine bytes (with the exception of the 'example' calling program given for the routine).

When you press '8' (which starts the program), the screen will clear and nothing will happen for between zero and about five seconds (this is a random delay, included so that you can't predict when the reaction testing will start — this will become clearer when you start to use the program).

At the end of the delay period, an exclamation mark '!' will appear at the left of the screen, and the tone will begin to sound. As soon as this happens, press any key from 0 to F (it doesn't matter which one). The tone will stop, and the screen will show a time in seconds and hundredths of a second, which is the time between the '!' appearing and you pressing a key.

The display should be two digits (showing seconds, with a maximum of about 2), then a colon ':', then another two digits, showing hundredths of a second. A normal score is about 00:20.

For reasons that will become apparent later, the display will only go up to 02:55 — but this should be plenty (unless you're too drunk to find the keys).

Reaction time can be used to measure the general alertness of a person — once you get the program working, try using it with your eyes shut (the tone will tell you when to press the key). By comparing your score with your eyes open, you can find out whether you respond faster to sound or visual stimulus.

Having done that, try it with some background noise, too. You should find that your response time to noise is much less when you are listening to music at the same time. What does that tell you about the life expectancy of people who cross the road while wearing one of those little portable cassette players?

### REACTION TIMER

```
0600  I=06D0               A6D0
   2  VB=00                6B00
   4  VC=14                6C14
   6  V0 = RND AND FF      C0FF
   8  TIME=V0              F015
   A  V0=TIME              F007
   C  SKIP IF V0=00        3000
   E  GOTO 060A            160A
0610  SHOW 5 @ VB, VC      DBC5
   2  VA=FF                6AFF
   4  TONE=VA              FA18
   6  TIME=VA              FA15
   8  VA=KEY               FA0A
   A  TONE=VB              FB18
   C  VA=TIME              FA07
   E  VB=VB+10             7B10
0620  VD=00                6D00
   2  V3=FF                63FF
   4  V3=V3-VA             83A5
   6  V3=V3+V3             8334
   8  VA=64                6A64
   A  V3=V3-VA             83A5
   C  SKIP IF  VF=01       3F01
   E  GOTO 0634            1634
0630  VD=VD+01             7D01
   2  GOTO 062A            162A
   4  V3=V3+VA             83A4
   6  DO 0704              2704
   8  I=06D5               A6D5
   A  SHOW 5 @ VB, VC      DBC5
   C  VB=VB+05             7B05
   E  VD=V3                8D30
0640  DO 0704              2704
   2  GOTO 0642            1642
THE FOLLOWING SHOULD ALSO BE
LOADED (THIS IS THE DATA FOR
THE '!' AND THE ':').
06D0  1010
   2  1000
   4  1000
   6  4000
   8  4000
```

A program to measure your reaction time — the time taken to respond (by pressing any key) to an exclamation mark appearing on the screen. The time is shown in seconds and hundredths of a second.

This program makes use of the 'two-digit print' routine, which should be loaded into locations 0704-0716.

## How it works

The first few statements are involved in just setting up the initial conditions for the test.

I (the memory pointer) is set to 06DO, which is the position in memory where the '!' screen display resides.

VB and VC (which control screen position in all the output) are set to a position half-way down the left-hand side of the screen.

V0 is used to give the random delay at the start of the program. The V0 = RND AND FF statement sets V0 to a random number between 0 and 255.

The TIME = V0 statement sets the timer to the value in V0. Immediately, the timer will begin to decrease in value at the rate of 50 per second, so that it will reach 0 at a maximum of 255/50 = 5 seconds after the start of the program.

Statements 0608, A, C and E form a 'loop' — something that you'll see again and again in programming. The first statement sets V0 to the current timer value (which, remember, is decreasing of its own accord all the time).

Statement 060C checks to see if the value in the timer has reached 0 yet (V0 is used to store the timer value because CHIP-8 does not have a statement which will test the value in the timer directly).

If the timer is still not 0, then the statement at 060E will send the machine back round the loop. This will go on until the value in the timer *does* reach 0. When this happens, the 060C statement will cause the machine to jump to 0610.

Statement 0610 puts the '!' on the screen, and the race is on!

VA is simply used at statement 0612 to store the value FF, which is loaded into TNE (thus turning the tone on), and also into TIME, setting the timer to FF.

Having done this, the machine will be sitting with the tone on, the '!' on the screen and the timer ticking away from FF.

Now the program (at statement 0618) asks for a key to be pressed. Here, we're not really interested in *which* key is pressed, but rather *when* it is pressed.

So the machine will sit at statement 0618 and wait for a key to be pressed. As soon as it is, the program will move on to the next statement. This is 061A, which sets the TONE to the value of VB (which just happens to be 0). This will stop the tone.

The value of the timer is stored in VA, so the response time is held in VA (and we don't have to worry about what the timer is doing any more). This response time will be given by the difference between the value in VA and FF, in fiftieths of a second.

At statement 061E, the value of VB is increased, so that what we next put on the screen (which will be the result) will not over-write the '!'.

Now at statement 0620, we can start to manipulate the value in VA so that we get two numbers — one the number of seconds and the other the number of hundredths.

First, we set VD at 00, then we set V3 to FF.

In order to understand fully the workings of the following part of the program, try setting out on a bit of paper the values in the variables used, and following through the section of program with a value in VA of 10 (hex), changing the values written on the paper as they would change in the machine. I'll explain it too.

At statement 0624, we subtract FF from VA. So the value in V3 is now the difference between VA and FF. The value in V3 is now actually the number of fiftieths of a second that the reaction time took.

Now we have to make that into hundredths of a second, and the 0626 statement does that. What it says is 'take the value in V3, add it to the value in V3 and put the result into V3'. So in other words it's doubling the value in V3.

V3 now holds the number of hundredths of a second. Now we have to find out the number of seconds (because this is displayed separately). We can do this by subtracting 100 from the value in V3 and then checking whether the answer is below zero. By counting the number of times we can subtract 10 (decimal) *without* getting an answer below zero, we can determine how many hundreds are there.

As a first step, we set VA to 64 (hex), which is 100 decimal. That's done at statement 0628.

Then we subtract VA from V3. Now if the result of a subtraction is less than zero, VF (and always VF) is set to 00. So if the answer is still more than zero, statement 062C sends the machine to 0630, which adds 01 to VD and then sends it back round the loop to 062A to subtract *another* 100.

This will happen until the answer given by the subtraction is less than zero. By this time, VD will hold the number of times that we have gone round the loop (i.e: the number of hundreds). When the answer to 062A is *less* than zero, VF will be set to 00, the program will go straight through 062C to 062E, and this will send it to 0634.

At 0634, 100 is added to V3 to bring it to the value it was at *before* the last subtraction (this will be the number of hundredths).

So by the time we get to 0634, VD will hold the number of seconds and V3 will hold the number of hundredths of a second.

0636 will send the program to the two-digit print routine (see earlier), and this will put the value of VD (whole seconds) onto the screen at VB, VC.

Then 0638 sets I to point to the screen image of a ':', which we loaded starting at location 06D5. 063A puts the colon onto the screen. 063C moves VB to the right so that the next two digits are in the right place, then 063E puts the value of V3 (hundredths) into VD, and 0640 causes it to be put onto the screen.

The last statement is a useful one to notice — 0642 GOTO 0642 will send the program into an endless loop (quite ▶

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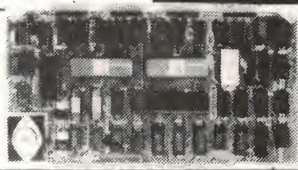
| 4 Boards for 16 User System. |  MPC-4 Multi-Port Communicator | Z80-CPU, Real Time Clock, Progr. Baud Rate Gen., 1 K RAM (Static), 2 x Z80-Darts, 2K PROM (2716), Fifo Buffer, Z80-CTC. | $680 |
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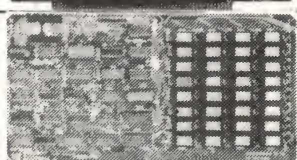
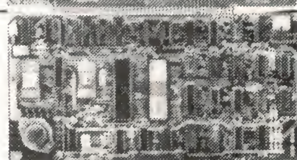
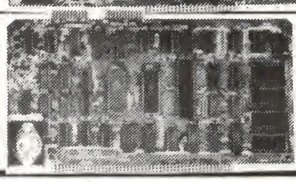
| 1 Board for Single User, 8 Boards for 16 User System. |  EXPANDORAM II Dynamic Ram Card | Expandable Dynamic Memory 16K-256K, Selectable Boundaries, Up to 4MHz Operation, Phantom Output Disable, Page Mode Operation, Uses 16K (4116) or 64K (4164) Memory Devices. | 16K—$475 32K—$510 48K—$545 64K—$580 |
| 1 Board for Single or Multi-User System. |  VDB-8024 Video Display Board | 80 characters x 24 lines, 7 x 10 Matrix, Composite or TTL Video Output, Keyboard Power & Interface, Forward & Reverse Scrolling, Blinking, Underlining, Field Reverse, Field Protect and Combinations, Full Cursor Control, 96 Upper and Lower Case Characters, 32 Special Character Set, 128 Additional User Programmable Characters (Optional), On-Board Z80-CPU, 2K BYTES Independent On-Board Ram Memory, Glitch-free Display. | $520 |
| 1 Board for Single or Multi-User System. |  SBC-200 Single Board Computer | Computailor Monitor 2K PROM (2716) Z80-CPU, 1K RAM, 16K EPROM, Serial I/O, Parallel I/O, Z80- CTC, 4MHz Operation, Optional Vectored Interrupts, Power-on jump to 4 K boundaries, On-board memory can be switched out under programme control. **Free: Computailor Monitor PROM (2716).** | $495 |

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harmless if used properly), so that the machine, having displayed the result of the reaction test, will sit and do nothing until you press RESET.

## Clock

This program uses the 'two-digit print' routine, too.

When it first starts up, it will put a time onto the screen, and then start updating it, giving a 12-hour display of hours, minutes and seconds, updated once a second.

Unfortunately, it's not too accurate (a few seconds per hour), but it shows what can be done — and with a bit more ingenuity we can improve the accuracy.

The time that the clock starts at is determined by the initial values of V3, 4 and 5, as set in statements 0604 to 0608 of the program. V3 is hours, V4 minutes and V5 seconds.

Remember to set them to reasonable values, otherwise the program will not work (V3 has to be from 01 to 0C, V4 and V5 from 00 to 3B).

**CLOCK**

```
0600  V7=33              6732
   2  TIME=V7            F715
   4  V3=00              6300
   6  V4=00              6400
   8  V5=00              6500
   A  VB=0D              6B0D
   C  VC=14              6C14
   E  CLR SCREEN         00E0
0610  VD=V3              8D30
   2  DO 0704            2704
   4  I=06D5             A6D5
   6  SHOW 5 @ VB, VC    DBC5
   8  VB=VB+05           7B05
   A  VD=V4              8D40
   C  DO 0704            2704
   E  I=06D5             A6D5
0620  SHOW 5 @ VB, VC    DBC5
   2  VB=VB+05           7B05
   4  VD=V5              8D50
   6  DO 0704            2704
   8  V6=TIME            F607
   A  SKIP IF V6=00      3600
   C  GOTO 0628          1628
   E  TIME=V7            F715
0630  V5=V5+01           7501
   2  SKIP IF V5=3C      353C
   4  GOTO 060A          160A
   6  V5=00              6500
   8  V4=V4+01           7401
   A  SKIP IF V4=3C      343C
   C  GOTO 060A          160A
   E  V4=00              6400
0640  V3=V3+01           7301
   2  SKIP IF V3=0D      330D
   4  GOTO 060A          160A
   6  V3=01              6301
   8  GOTO 060A          160A
THE FOLLOWING SHOULD ALSO BE
LOADED (THIS IS THE DATA FOR
THE ':').
06D4  0000
   6  4000
   8  4000
```

**A program to put an hours:minutes:seconds 12-hour clock display onto the screen (accurate to a few seconds per hour, unfortunately).**

**This program makes use of the 'two-digit print' routine, which should be loaded into locations 0704-0716.**

## How it works

The first statement sets the length of the timing loop (that's like the little adjustment screw in your old analogue watch — no, your digital watch hasn't got one!)

Adjusting the value of V7 will vary the speed of the clock. I found a value of 33 hex to be about right.

Statement 0602 sets the value of the timer to that of V7, so that from this point, the timer is ticking down towards zero at a rate of 50 per second.

The next three statements set the initial values of the hours, minutes and seconds digits.

Statements 060A and 060C set the values of VB and VC, which control the position of the display on the screen. The values I've put in give a display that's about central.

The 00E0 instruction sends the program momentarily to a little machine code routine somewhere deep inside the monitor that clears the screen.

If you have a look at the 'two-digit print' routine, you'll notice that VD is used to carry the number that is to be put onto the screen.

So statement 0610 sets VD to the first part of the display — the hours digit.

0612 sends the program to the print routine, and this puts the value of VD on the screen at a position set by VB and VC, and also updates the value of VB to move it to the right.

0614 sets the memory pointer to the screen image of a colon ':', which you have entered at 06D5 (the byte at 06D4 is not important, by the way).

Statement 0616 puts the colon onto the screen. Then 0618 increases the value of VB, which makes sure that the next part of the display is in the right place.

By this time, you should be able to follow the rest of the program up to 0626 by yourself — all that's happening is that the minutes display is put on the screen, followed by another colon, and then the seconds display.

Now comes the timing loop. 0628 sets V6 to the value of the timer, and 062A checks to see whether it has reached zero yet (which it will do about a second after being set at statement 0602).

If the timer has not yet reached zero, statement 062A has no effect, and statement 062C will send the program back round the loop to check on the timer again.

When it does reach zero, statement 062A will send the program to 062E, where the timer will immediately be set to V7 again, ready for the next timing period.

While the timer is counting down to zero again (and this happens fairly slowly in terms of the rest of the program), the machine can be doing a lot of other things.

So the timer is set in 062E, and the program changes the values in V3, 4 and 5 and redisplays them, getting back to the timing loop at statements 0628 to 062C in plenty of time to catch it before the timer reaches zero again.

Statement 0630 is the seconds digit being updated. If it is less than 60 decimal, nothing else needs to be done, and so statement 0632 has no effect and 0634 sends the program back up to 060A (notice that it is necessary to re-initialise the value in VB to have the display in the same place next time).

If, however, the seconds display *has* reached 60 decimal, then statement 0632 sends the program to 0636, which sets the seconds to zero.

The next statement increases the minutes digit (V4) by one, and the following statements check to see if *it* has reached 60. If it has not, we go back to 060A — if it *has,* then the minutes are also set to zero and the *hours* are increased by one.

Statement 0642 is worth looking at. This and the following statements check to see whether the hours have reached 13 decimal. If it has, it sets it to 1 decimal. So the display will go from 12 o'clock to 1 o'clock. Notice that this little section of the program is slightly different from the parts that update the seconds — that's because logically we should count from 0 o'clock to 11 o'clock and then back to 0 o'clock!

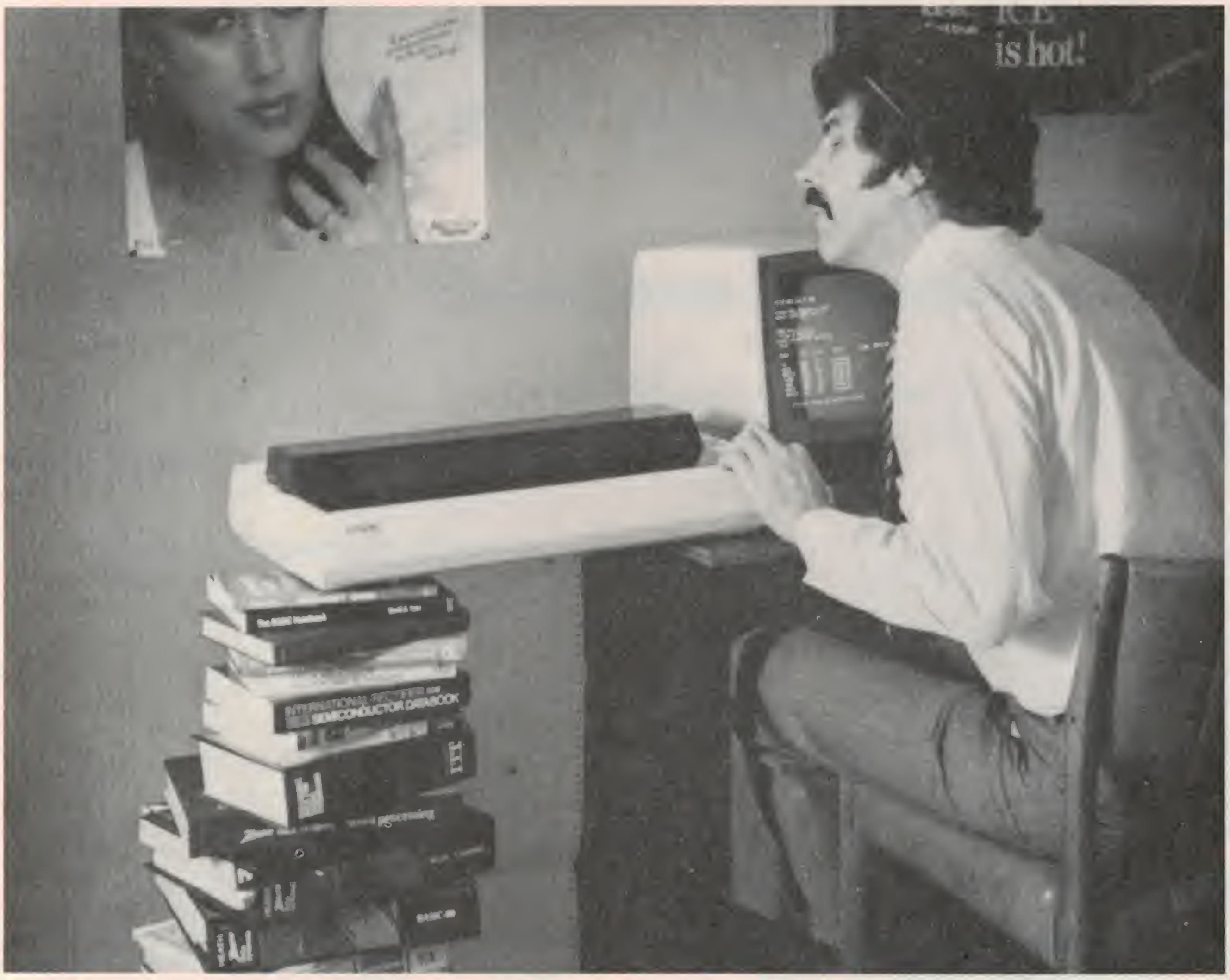
By the way, if you want to make it a 24-hour clock, you'll have to alter the following statements:

0642 SKIP IF V3=17 3318

and

0646 V3=00 6300

Now can you see why some people (especially computer programmers) prefer a 24-hour clock? ●

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WF820/81

# Programming the '660 in colour

## ( . . . painting by numbers!)

For constructors of the ETI-660 (or about-to-be constructors), here's how to get it to put colour on your TV screen!

**Phil Cohen**

NO DOUBT, having got your '660 going, you've been hankering to try it out in lurid colour! Sorry to keep you waiting, but you'll find it has been worthwhile. First of all, though, you're going to have to do a minor modification, as detailed in the accompanying panel. The modification permits colouring all the available blocks on screen, not every other one — something we didn't know originally, despite the fact we had a demo program tape. Well, nobody's perfect! OK — on with it!

### How it Works

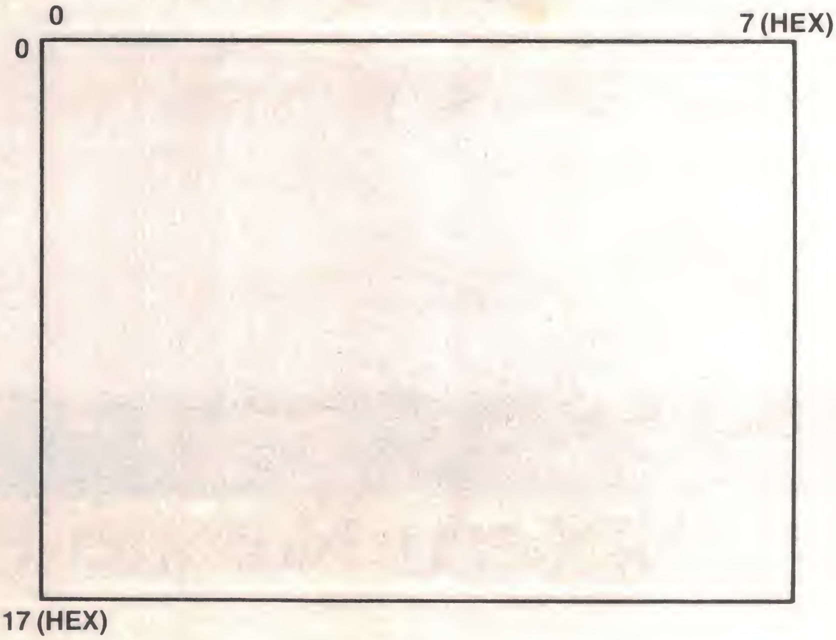
Referring to your circuit (Nov. '81), IC16 is the colour RAM — it stores information about the colour of the various parts of the screen. Each location in IC16 contains three bits. These three bits give one of eight colours for the screen area. A screen area is eight 'pixels' wide and two high, a pixel being the smallest part of the screen that you can turn on. The display on the screen contains 3072 pixels in total; if you turn the whole screen display on, all 3072 pixels are used.

The screen colour, then, can be set in a matrix eight wide by 24 high — this is the number of 'areas' on the screen.

When the 1864 (IC4) asks the processor to send it the screen RAM information, the processor will step through the screen memory one byte at a time, and the information will go via the data buss into the 1864. As this is happening, the address information is also being fed to IC16, and it will respond by putting its three bits of colour information out at pins 12, 14 and 16.

These will reach the colour input pins of the 1864, and cause it to set the colour of the various parts of the screen.

The software given here will allow you to write your own colour programs in CHIP-8, without having to worry about quite how the machine code part of the system works. However, when you graduate to writing programs in machine code, you will need to know how the colour is set.

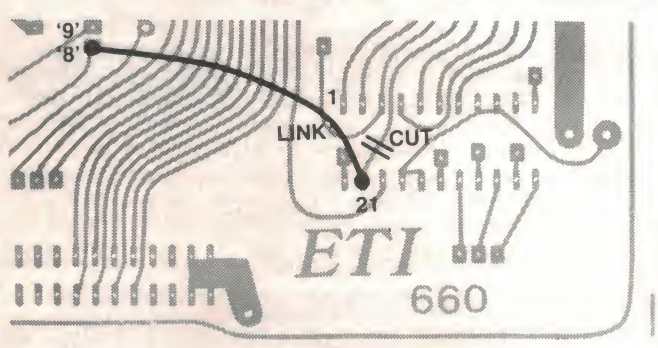



### A SMALL MODIFICATION

Take your naked '660 pc board (i.e: with the case stripped off). Modestly position the board so that the keyboard faces away from you. Now turn the board over. On your right, at the bottom edge of the board, you should spy 'ETI 660'. Now you're ready to do the deed. Just above the ETI 660 marking you'll find the pins for IC16. Identify pin 21. A track runs from pin 21, between pins 3 and 4, to a feedthrough link pad between IC16 and IC10. Cut the track as indicated on the diagram here. Remove the copper for about 2 mm; a Stanley knife is good for this job. Don't use a drill to cut the track — you may cause damage on the top side of the board.

Now cut a length of insulated hookup wire about 45 mm long, and bare and tin both ends. Using this, join pin 21 of IC16 and the pad shown in the diagram here.

To check that you've done it properly, identify the corresponding pad on the top side of the board. It should be marked '8'. Now you can put the '660 back together and get on with your colour programming.



This is how it's done: the byte that holds the colour information in its lower three bits is written into the screen memory at the position required. As the 1802 is a static processor, the address and data information will remain there after this has been done. Immediately after this memory transfer, execute an 'OUT 3' instruction. This will cause the 1864 to pulse the R/W pin of IC16, clocking the information in.

In fact, the above procedure will write into the screen RAM as well — there's no need to do that too.

The screen RAM will notice if bit 9 of the address is set, and if it is, will not respond. However, IC16 is not connected to bit 9, and so the routine becomes as follows:

a. Decide on the colour and set the lower three bits of a byte accordingly.
b. Decide on the screen position and translate that into an address. Now set bit 9 of the address.
c. Put the colour bit into memory at the address (an STR instruction will do this).
d. Execute an OUT 3.
   Happy colouring!

## Colour routines

I've put all the colour software up into the 'top' of memory — that is, I've arranged it so that it finishes just on location 07FF, which is the last one. This leaves the maximum amount of room for the main program.

The first routine, which is entered by inserting an 07C1 into the CHIP-8 program, turns on the colour facility.

This routine is fairly self-explanatory for those who understand machine code — and for the rest, well, you'll just have to wait until we explain the 1802 machine statements! Alternatively, you could get hold of 'Programmer's Guide to the 1802' by Tom Swan (see p.96, March '82).

The next routine alters the background colour; it's called by an 07A2 in the CHIP-8 program. When you first turn the machine on, the background colour will be blue. If you then call the routine at location 07A2, the background will change to black. The next call of the routine will set it to green, and the next to red. A further call will set it to blue again.

So, by the number of calls that you have at the start of your main program, you can choose the background colour you want. NOTE: In order to use this routine, you do not have to run the one that enables the colour.

The last routine is a CHIP-8 one, which in turn calls a machine code

### COLOUR ROUTINES

There are three routines here, all jammed together at the top of memory to allow the maximum amount of room for the rest of the program. The first is a machine code routine which **enables the colour** facility, and it is called from the main program by an **07C1** CHIP-8 instruction — i.e. 'run a machine code routine at location 07C1'. The next routine **alters the colour of the background** in the sequence 'blue, black, green, red, blue ...'. Each time the routine is called, the background colour will advance one — it starts with blue, and so after the first call of the routine the colour will be black, and so on. This routine is called from CHIP-8 by an **'07A2'** instruction. The third routine allows you to **alter the colour of a two-byte area** of the screen. Set VE to the horizontal co-ordinate (from 0 to 7), VF to the vertical co-ordinate (from 0 to 17 hex), and VD to the colour, according to this table:

| | |
|---|---|
| 0 | black |
| 1 | red |
| 2 | blue |
| 3 | violet |
| 4 | green |
| 5 | yellow |
| 6 | pale blue |
| 7 | white |

The routine is called from CHIP-8 by a **'27AB'** instruction — that is, 'call the CHIP-8 subroutine at location 07AB'. Locations 07A5 to 07AA are reserved for use by these routines. Before you use any of these routines, make sure that you modify the hardware as described in the article.

```
07A2  SEX 9         E9
   3  OUT 1         61
   4  RETURN        D4

07A5 TO 07AA RESERVED

07AB  I=07A5        A7A5
   D  M(I)=V0:V2    F255
   F  V0=VD         80D0

07B1  V1=VE         81E0
   3  V2=VF         82F0
   5  I=07A8        A7A8
   7  M(I)=V0:V2    F255
   9  I=07A5        A7A5
   B  V0:V2=M(I)    F265
   D  CALL 07D1     07D1
   F  RETURN        00EE
```

```
07C1  LDI 39    F839
   3  PLO F     AF
   4  GHI 6     96
   5  PHI F     BF
   6  SEX F     EF
   7  LDI 2C    F82C
   9  STR F     5F
   A  OUT 2     62
   B  DEC F     2F
   C  LDI 20    F820
   E  STR F     5F
   F  OUT 2     62
07D0  RETURN    D4
-------------------
   1  LDI 07    F807
   3  PHI E     BE
   4  LDI A8    F8A8
   6  PLO E     AE
   7  SEX E     EE
   8  LDXA      72
   9  ANI 07    FA07
   B  PHI F     BF
   C  LDX       F0
   D  ANI 07    FA07
   F  STR E     5E
07E0  INC E     1E
   1  LDX       F0
   2  ANI 1F    FA1F
   4  SHL       FE
   5  SHL       FE
   6  SHL       FE
   7  SHL       FE
   8  STR E     5E
   9  LDI 0C    F80C
   B  ADCI 00   7C00
   D  PHI D     BD
   E  LDI 80    F880
07F0  ADD       F4
   1  PLO F     AF
   2  GHI D     9D
   3  ADCI 00   7C00
   5  PHI D     BD
   6  GLO F     8F
   7  DEC E     2E
   8  ADD       F4
   9  PLO D     AD
   A  SEX D     ED
   B  GHI F     9F
   C  STR D     5D
   D  OUT 3     63
   E  SEX 2     E2
   F  RETURN    D4
```

# Computer retailers... If you're not selling our software you're probably losing sales.

routine. In order to use this routine, first set VE to the position *across* the screen whose colour you want to set (left hand side of the screen = 0, right hand side = 7).

Then set VF to the position *down* the screen (top of the screen =0, bottom = 17 hex).

Now set VD to the colour you want (according to the table given next to the program) and you're set.

Then all you have to do is put in a 27AB instruction, which will send the program to the CHIP-8 subroutine at 07AB. The first thing this does is to save in memory the contents of V0 through V2 (these variables are used by the routine). Then it puts the values of VD, VE and VF into memory in the area 07A8 to 07AA. Finally it restores the old values of V0 through V2 (so that these are not altered by the routine). It then calls the machine code routine at 07D1 and returns to the main program.

Again, I won't go into the complexities of the machine code routine at this stage — but those of you who have access to a book or two on the subject (like Tom Swan's, mentioned earlier) may like to work your way through it.

Those of you who don't know about machine code — well, just enter it in the same way as a CHIP-8 program (the only difference is that a line of machine code program sometimes has one byte in it and sometimes two — but if you start at the correct address and just keep going, you should be right).

## Colour test program

So that you can test out your routines properly, I've included a short program that 'exercises' all the software in the colour routines.

The first thing it does (statement 0600) is to call the routine that turns on the colour. Then (statements 0602 to 8) it sets location 0700 to FF (I could just have told you to do this, but it is a useful example of how to do it from inside a program). The next part of the program writes the contents of location 0700 (which is why we set it) to every location on the screen. It does this by means of two loops — one inside the other (this is called a pair of 'nested loops'). At the middle of the loops (which cause V0 to go from 0 to 7 and V1 to go from 0 to 36) is statement 060E, which actually puts the FF onto the screen. So by the time we reach 061E, the screen should all be on.

This is necessary for what we are about to do because if the screen is off, it will show the background colour (which at present is blue), so in order to see what effect we're having on the screen colour, we have to turn it *all* on. Normally, only the area of screen that was going to be used to display something would be set to a particular colour — but this way, we can see the colour of all of the parts of the screen.

Anyway, we've reached 061E, and the next thing that we do is to get from the keyboard the co-ordinates of the area whose colour we want to change, and then the colour that we want to set it to. Statement 0624 then sends the machine to the colour-changing routine. The next statement (0626) changes the background colour as well, just for good measure. Type in the colour routines, and then the test program. Then record what you have in memory onto tape.

Now set the program going. The screen background colour should be blue, and the middle part of the screen should start to go black from the top downwards. In fact, not all of it will be black — as the colour RAM has not been altered since you turned the machine on, the colour at the various points of the screen will be random. But most of it should be black.

Now press the following key sequence: 0, 0, 1.

Two things should happen simultaneously when you press the third key — the surrounds of the screen should go black, and the block in the top left hand corner should go red (if it wasn't red already).

Now do: 0, 1, 1. The screen colour should change again, and the next block down should go red.

*If the two red blocks are not next to each other (i.e: touching), then re-check the hardware modification described in this article.*

### COLOUR TEST PROGRAM

This little program will allow you to test the colour routines that you have just loaded. First load the colour routines (locations 07A2 to 07FF), then record them, then play them back into the machine, then load and run this program.

The program will first call the colour-enabling routine, then fill the screen, then wait for input.

Put in three digits, the first being the horizontal co-ordinate, the second the vertical co-ordinate and the third the colour. You should see the area that you specified change colour, and the background will change colour too. The program will then wait for the next three digits.

**NOTES:** The screen will come up first of all with a random colour setting — this is normal. Because you can only enter a single digit for the vertical co-ordinate, you will only be able to access the top two thirds of the screen.

| | | |
|---|---|---|
| 0600 | CALL 07C1 | 07C1 |
| 2 | V0=FF | 60FF |
| 4 | V1=00 | 6100 |
| 6 | I=0700 | A700 |
| 8 | M(I)=V0:V0 | F055 |
| A | V0=00 | 6000 |
| C | I=0700 | A700 |
| E | SHOW 1 AT V0, V1 | D011 |
| 0610 | V0=V0+08 | 7008 |
| 2 | SKIP IF V0=40 | 3040 |
| 4 | GOTO 060E | 160E |
| 6 | V0=00 | 6000 |
| 8 | V1=V1+01 | 7101 |
| A | SKIP IF V1=37 | 3137 |
| C | GOTO 060E | 160E |
| E | VE=KEY | FE0A |
| 0620 | VF=KEY | FF0A |
| 2 | VD=KEY | FD0A |
| 4 | **DO 07AB** | 27AB |
| 6 | CALL 07A2 | 07A2 |
| 8 | GOTO 061E | 161E |

### REACTION TIMER — COLOUR PATCHES

These two patches will convert the reaction timer to colour operation (you will need to load the reaction timer program, the two-digit print routine and the colour software, and then include the following changes and additions).

These will cause the '!' to appear red on a black background, and then the reaction time result to appear either red (if it's over 220 milliseconds) or green (if it's under). You may need to turn the brightness of your set up a bit for best results.

| | | |
|---|---|---|
| 0600 | CHANGE A6D0 TO GOTO 0650 | 1650 |
| 0628 | CHANGE 6A64 TO GOTO 0670 | 1670 |

| | | |
|---|---|---|
| 0650 | CALL 07C1 | 07C1 |
| 2 | CALL 07A2 | 07A2 |
| 4 | VE=00 | 6E00 |
| 6 | VF=0A | 6F0A |
| 8 | VD=01 | 6D01 |
| A | DO 07AB | 27AB |
| C | VF=0B | 6F0B |
| E | DO 07AB | 27AB |
| 0660 | VF=0C | 6F0C |
| 2 | DO 07AB | 27AB |
| 4 | I=06D0 | A6D0 |
| 6 | GOTO 0602 | 1602 |
| 0670 | VE=V3 | 8E30 |
| 2 | V1=VD | 81D0 |
| 4 | VD=04 | 6D04 |
| 6 | VA=18 | 6A18 |
| 8 | VE=VE-VA | 8EA5 |
| A | SKIP IF VF=00 | 3F00 |
| C | VD=01 | 6D01 |
| E | VE=02 | 6E02 |
| 0680 | VF=0A | 6F0A |
| 2 | DO 07AB | 27AB |
| 4 | VE=VE+01 | 7E01 |
| 6 | SKIP IF VE=05 | 3E05 |
| 8 | GOTO 0682 | 1682 |
| A | VE=02 | 6E02 |
| C | VF=VF+01 | 7F01 |
| E | SKIP IF VF=0D | 3F0D |
| 0690 | GOTO 0682 | 1682 |
| 2 | VA=64 | 6A64 |
| 4 | VD=V1 | 8D10 |
| 6 | GOTO 062A | 162A |

### ETI-660 — FURTHER EXPANSION

We are presently working on a number of expansion projects for the ETI-660 Learners' Microcomputer. In progress is a BASIC interpreter so that you can program the '660 in the most popular microcomputer language. We plan to make this available in ROM. Naturally, this will require a full-size QWERTY keyboard (ASCII-encoded) and we will be coming up with interfacing details. Then, you'll require more memory — a memory expansion board is 'in the pipeline'. Meanwhile, we have some more exciting programs coming. Stay tuned!

## Reaction Timer — colour

The reaction timer program published in this issue can be altered to make use of the colour facility.

This is done by a method known as 'patching'. This is the software equivalent of building a circuit using string and glue. It's not recommended for doing alterations to your own programs — and I've only used it here for simplicity.

What happens is that at a particular part of the program you insert a GOTO statement which sends the program to another part of memory. In this part of the memory is a routine that you wanted to insert into the program. You do the routine, and then GOTO back to the statement after the one you jumped from.

All this is done in an effort to avoid having to remember the whole program (or in this case, to avoid the tedium of having to re-enter the whole thing).

The first patch (which goes into the main program at 0600) turns on the colour (statement 0650), and then changes the background colour (0652) to black.

The next few lines change the colour of the part of the screen which will hold the '!' to red.

Notice that the screen will stay black at this area until we actually write something there.

The patch then does what the original statement 0600 did (statement 0664) and then jumps back to the statement after the altered one.

The next patch is more complex. What it does is to set the area which will hold the results to either green or red, depending on the results — so if your reaction time is OK, you get a green display, but if it's not, you get red.

The first statement copies the value of V3. This holds, at the point of the program we're coming from, the number of hundredths of a second of the reaction time. The next statement copies the value of VD. Since the colour routine uses VD, we have to store it at the start of this patch and then reset it at the end (statement 0694).

Statement 0674 *sets* VD (which is the colour variable) to 04 — green. VA is set to 18 hex, which is 24 in decimal.

The next couple of statements check to see whether the time is less than 24 hundredths of a second. Statement 0678 subtracts 24 decimal from the number in VE. If the answer is zero or less, VF will be set to 01, otherwise it will be set to 00.

So by looking at the value in VF at statement 067A, we can tell whether the result of the subtraction at statement 0678 was above or below zero — and if you think about it, this will tell us whether the value in VE was above or below 18 hex.

If the value in VE was *below* 18 hex, this means that the reaction time is OK — VF will be set to 00 at statement 0678, and statement 067A will cause the machine to skip statement 067C. If this happens, VD will remain at 04 — green. If the value in VE was *higher* than 18 hex, however, statement 067A will have no effect, and statement 067C will set VD to 01 — red. So by the time we reach 067E, VD will be either red or green, depending on the reaction time.

The next few statements (067E to 0690) simply use this value of VD to set the area of the screen which will show the reaction time display. Two loops are used, with VE (the horizontal value) going from 02 to 04, and VF (the vertical value) going from 0A to 0C. It will be instructive for you to follow these statements through for yourself.

The next two statements — 0692 and 0694 — set VA and VD to the values that they will need back in the main program. Notice that we have to set VA because the statement that we replaced (0628) to put in the patch did this originally. Finally, we jump back into the main program at 062A. ●

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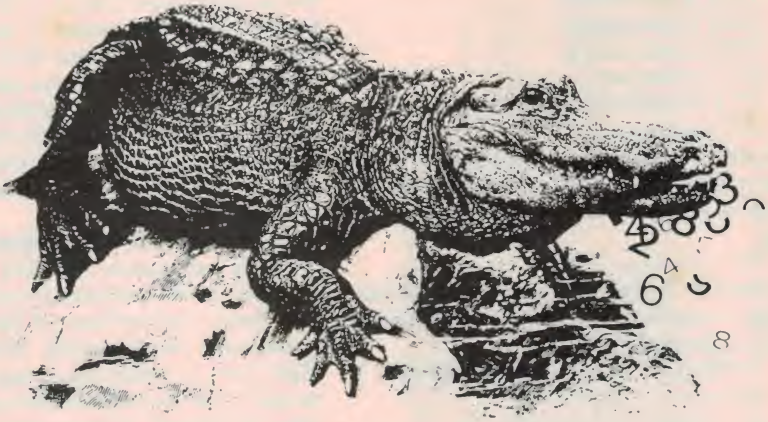


'Reverse Polish Notation' may sound like Pitjintjara if you're used to algebra, but it's the logical way to process masses of numerical information.

**Mike James**

THIS IS THE FIRST of two articles describing how the most important part of a high-level language compiler works. In this first part the principles involved, the LIFO stack and Reverse Polish notation are explained and a BASIC program to convert arithmetic expressions into Reverse Polish is presented. Part Two examines how to compile this notation into 6502 assembly code — i.e: how to generate a compiler for the Apple or the PET, etc. This program could easily be modified for use with another processor, such as the 6800 or 6809. From these articles, readers without knowledge of assembly language will learn something about how high level language compilers work and those with more advanced knowledge will find the techniques described useful in writing their own compilers.

## Why bother?

One of the most difficult tasks confronting the budding software expert is the translation of what appear to be simple arithmetic expressions into assembly language. After all, we have high-level languages such as BASIC that swallow A + B*C and spit out the answer in one statement.

The reason is two-fold. First, the implementation of high-level languages is still poor on most micros. Second, there are still few such languages available on micros. Both these reasons should encourage an interest in the production of new compilers. It should also be pointed out (perhaps 'admitted' is better) that writing a compiler is one of the most difficult projects that can be undertaken. So if you are bored with writing games of the 'ZAP the enemy' type, try a compiler — for an existing language or, even more of a challenge, for one of your own inventions.

The trouble with expressions like A + B*C is that more than one operation, in this case two (one addition and one multiplication), have to be carried out before the result is obtained. In general computers can only do one thing at a time, so any complex expression would have to be split down as in the following example:

"Add A to B"
"Multiply the result by C"

Even this description is incomplete (in fact it is also wrong if applied to the expression A + B*C, but more of this later), for the computer has to put the result of adding A to B somewhere, i.e: in a temporary location, before multiplying by C.

These temporary locations have to be created automatically as required by the translation program and it is something of a problem to keep their number small. It is possible to avoid using temporary storage locations as such by the use of a 'stack'. This also brings other advantages in that the translation program is simpler.

## A LIFO stack

A 'Last In, First Out' (LIFO) stack is very easy to understand. A good model is a shunting yard. If we consider a railway line as in Figure 1 with three wagons, A, B and C, then if we shunt A, B and C into the siding in that order (Figure 2) then the first wagon out will be C, the last in. Next out will be B and then A.

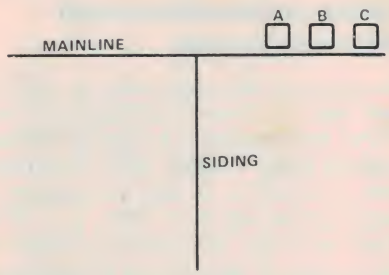


*Figure 1.* **The shunting yard before the trucks are 'pushed' into the stack . . .**

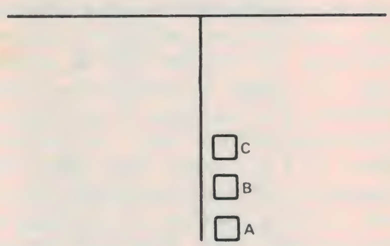


*Figure 2.* **. . . and the result after they have been 'pushed'.**

In computer terms, a stack is an area of memory and two instructions, PUSH (usually abbreviated to PSH) and PULL (usually abbreviated to PUL), are used to place an item. To use our railway sidings model/analogy once again, if a wagon is outside the siding a PSH is required to put it inside; if a wagon is in the siding a PUL removes it.

Thus our shunting sequence would correspond to: ▶

PSH A into siding
PSH B into siding
PSH C into siding
PUL removes C
PUL removes B
PUL removes A

A stack can be implemented in BASIC as a string of characters, e.g: Z$. Pushing an item or character on to the stack is:

Z$ = 'character' + Z$

where '+' in this case means concatenation — simply joining the two strings to form a longer string.

Pulling an item from the stack is:

'character' = LEFT$(Z$,1)
Z$ = RIGHT$(Z$,LEN(Z$)−1)

where LEFT$(Z$,n) gives the n left hand characters of the string, LEN(Z$) gives the length of the string and RIGHT$ (Z$,n) give the right n characters of the string.

At this point it might be helpful to write a program, namely to reverse the order of a string of letters. The answer is given at the end of the article but try it for yourself before looking at it in detail.

## Order, precedence and Reverse Polish!

To return to the reason why A + B*C is not 'add A to B then multiply by C', it is worth realising that you get a different answer from 'multiply B by C and then add A' which is in fact the correct interpretation, e.g: 2 + 3*4 = 2 + (3*4). That is to say, the *order* in which the calculation is carried out *is* important. How we define the order of evaluation of an arithmetic expression is to some extent arbitrary, but it is usual to carry out all multiplications and divisions first and then any additions and subtractions. To express this in another way, we assign a precedence to each operator. For example, if we assign a precedence of 1 to + and − and a precedence of 2 to * and / and agree that operators of higher precedence are carried out first, then we are adopting the conventional rule. The usual precedences are given in Table 1.

| | | |
|---|---|---|
| + | 1 | |
| − | 1 | |
| * | 2 | |
| / | 2 | |
| + | 3 | UNARY + |
| − | 3 | UNARY − |

Table 1. Precedence values for arithmetic operations.

So we now know that A + B*C means, by convention, B times C plus A. But how do we write A plus B all times C? The answer is of course to use brackets '()'. We can alter the order of operator by simply asking that any sub-expressions in brackets are evaluated *first*. Thus A plus B all times C would have to be written (A + B)*C.

Now we have a way of specifying the order of evaluation we meet the main problem in the computer evaluation of arithmetic expressions. If the order of evaluation were strictly from left to right then a computer program could simply read the expression and, apart from problems of temporary storage, could carry out each operation on the pair of variables to either side (as in our first example). However, as we have just discovered, the order of evaluation is not from left to right and if we ignore this fact we obtain the wrong answer.

Life would be a lot easier if we could find some way of writing arithmetic expressions so that the order of evaluation was always from left to right. This would mean that as we scanned the expression each operation could be carried out as soon as it was encountered and brackets would be unnecessary. Such a notation exists and is called 'Reverse Polish' — so called because of the unpronounceability by English speakers of the name of its inventor, Lukasiewicz, a Polish logician.

An expression in Reverse Polish (RP) is evaluated by scanning from left to right until an operator is met. When this happens the operator is applied to the two variables immediately to its left. The result is considered to be left in the expression, replacing all the variables and symbols involved. An example will make this clear.

Consider:

AB*C+

If we follow our rule, the first operator we encounter is '*' and the two variables to its left are A and B, so we form A*B and put the result, T say, in place of AB* to give:

TC+

To continue, the next operator is '+' and we form T+C. So, to put the original expression into conventional notation we have:

(A*B)+C

As an exercise try evaluating:

3,4*6+3/

The answer is given at the end of the article.

We could insist that everyone learns RP, which is what some calculator manufacturers have done, or we could convert standard arithmetic expressions into RP. Using the concept of a stack this is easy.

## The shunting yard algorithm

Obviously if we are going to read an RP expression from left to right but jump all over the place in an equivalent 'standard' expression then we are going to have to change the order of the operators when converting to RP. From the earlier example involving reversing a sequence of letters, it can be seen that a stack is useful in changing the order of a set of symbols. It is this ability which lies at the heart of the shunting yard algorithm. The algorithm uses a stack to change the order of the operator so that all high precedence operators and brackets are evaluated first. It works like this:

- If you encounter a variable name pass it to the output.
- If you encounter an operator stack it (i.e: push it on to the stack) unless there is an operator already on the stack with a higher precedence.
- If this is the case then the operator already on the stack should be carried out first so unstack it and pass it to the output.
- Repeat until you can stack the operator and then move on to the next item in the expression.

Brackets can be dealt with by starting a new stack when the opening bracket is encountered and by finishing evaluation when the closing bracket is encountered. Usually we do not start a new stack but simply place a marker on the old stack to indicate where the bracket was encountered (this might as well be the opening bracket itself). The full shunting yard algorithm can be seen in Figure 3.

Listing 1 shows a BASIC program that will convert any valid arithmetic expression into RP, with examples of its output given after it. The only complication with the BASIC program lies in the use of the unary + and − signs. The minus in A−B has a different meaning from the one in −A, similarly the plus in A+B does not mean the same as the one in +A. The program detects these unary symbols by checking if an operator or a variable was the last thing to be processed. If it was an operator or nothing then a + is converted into a ? and a − into a ! to show that they are unary. In calculations an RP expression or a binary operator is treated in the usual way except that it acts only on the *first*

variable to its left. The only other comments on the program are:

- W(I) is used to hold the precedence of the operators.
- Z$ is the stack and Z(I) contains the precedence of the items on the stack.
- MID$ A($,I,J) returns the J characters in the string starting at the Ith.

The parts of the program can be followed from the line numbers on Figure 3.

## Summary

This article has introduced the reader to the LIFO stack and to Reverse Polish notation. A subroutine to convert an arithmetic expression to RP has been presented. Next time, again making use of the stack concept, we will show you how to compile an RP expression into 6502 assembly language (or into code for the 6800 or 6809 with certain modifications). Oh, the answer to 3,4*6+3/ is 6. ●

```
10  INPUT A$
20  IF A$="" THEN GOTO 50
30  Z$=A$+Z$:REM**PUSH INPUT
    ONTO STACK
40  GOTO 10
50  IF Z$="" THEN STOP
60  A$=LEFT$(Z$,LEN(Z$)-1)
70  Z$=RIGHT$(Z$,LEN(Z$)-1)
80  PRINT A$
90  GOTO 50
```

**This is the program to demonstrate the action of a LIFO stack.**

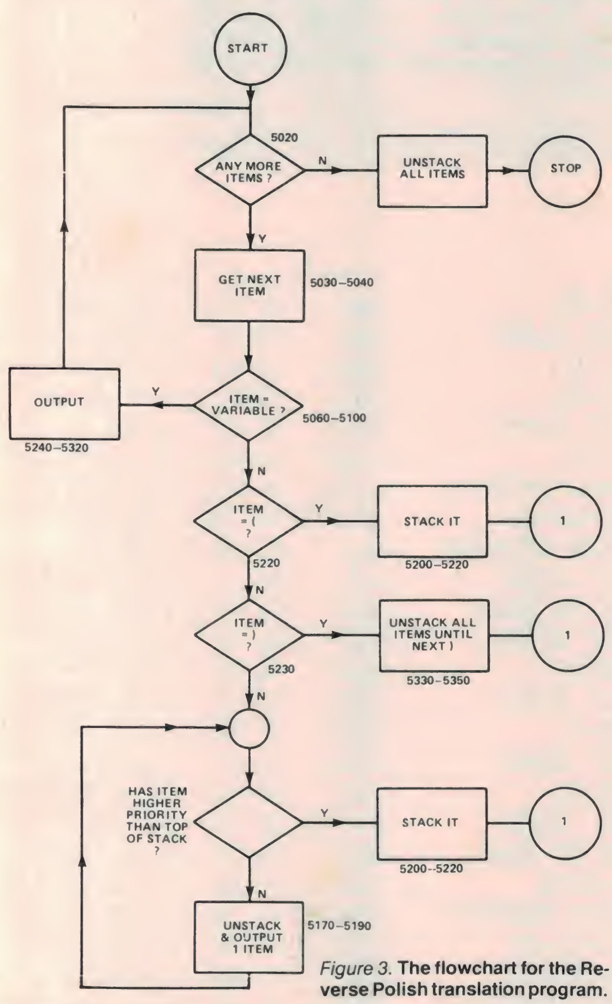


*Figure 3.* **The flowchart for the Reverse Polish translation program.**

# Program Listing

```
  10  DIM Z(25),W(5)
  20  U$="-+*/()"
  30  W(1)=1:W(2)=1:W(3)=2:W(4)=2:
      W(5)=0
  40  INPUT A$
  50  I=1
  60  GOSUB 5000
  70  PRINT A$,C$
  80  GOTO 40
4999  REM**REVERSE POLISH ROUTINE
5000  Z$="":C$="":X=1:O=1
5010  FOR J=1 TO 25:Z(J)=0:NEXT J
5020  IF LEN(A$)<I THEN 5420
5030  B$=MID$(A$,I,1)
5040  IF B$="[SPC]" THEN I=I+1:GOTO 5020
5050  K=0
5060  FOR J=1 TO 6
5070  IF B$=MID$(U$,J,1) THEN K=J
5080  NEXT J
5090  IF K=6 THEN 5330
5100  IF K=0 THEN 5230
5110  S=W(K)
5120  IF S=0 THEN 5200
5130  IF S=1 THEN 5380
5140  O=1
5150  IF X=1 THEN 5200
5160  IF Z(X-1)<S THEN 5200
5170  C$=C$+LEFT$(Z$,1)
5180  X=X-1:Z$=RIGHT$(Z$,LEN(Z$)-1)
5190  GOTO 5150
5200  Z(X)=S
5210  Z$=B$+Z$:X=X+1:I=I+1
5220  GOTO 5020
5230  O=0
5240  IF B$<"A" THEN 5280
5250  IF B$>"Z" THEN 5280
5260  C$=C$+B$
5270  I=I+1
5280  IF B$>"9" THEN 5020
5290  IF B$<"0" THEN 5020
5300  C$=C$+B$
5310  I=I+1
5320  GOTO 5020
5330  IF LEN(Z$)=0 THEN I=I+1:GOTO 5020
5340  B$=LEFT$(Z$,1):Z$=RIGHT$(Z$,LEN(Z$)-1):
      X=X-1
5350  IF B$="(" THEN I=I+1:GOTO 5020
5360  C$=C$+B$:GOTO 5330
5370  IF O=0 THEN 5140
5380  S=6
5390  IF B$="-" THEN B$="!"
5400  IF B$="+" THEN B$="?"
5410  GOTO 5140
5420  C$=C$+Z$
5430  RETURN
```

```
 RUN
? A+B
A+B                    AB+
? A+B*C
A+B*C                  ABC*+
? A*B+C
A*B+C                  AB*C+
? A*(B+C)
A*(B+C)                ABC+*
? -A+B
-A+B                   A!B+
? -(A+B)*C+(D*E)
-(A+B)*C+(D*E)         AB+!C*DE*+
? -(A+B)*(C-D)
-(A+B)*(C-D)           AB+!CD-*
```

**A typical output from the above program. The entered algebraic expressions are converted to RPN.**

# One-handed pong

Upon loading this game, a 'field' of 'spots' appears in the top half of the screen and a 'bat' at the bottom. You can serve up to twenty balls with your bat by pressing any key other than 4 or 6. These keys move the bat left and right respectively. Each spot hit disappears and you accrue one point per hit. Sound effects are included. You can widen the paddle by changing the E0 byte at 06CD (right at the end of the program) to F8 or FF.

```
0600  A6 CC  I=06CC
0602  6A 07  VA=07
0604  61 00  V1=00
0606  6B 08  VB=08
0608  60 00  V0=00
060A  D0 11  SHOW 1MI@V0V1
060C  70 08  V0+08
060E  7B FF  VB+FF
0610  3B 00  SKF VB=00
0612  16 0A  GO TO 060A
0614  71 04  V1+04
0616  7A FF  VA+FF
0618  3A 00  SKF VA=00
061A  16 06  GO TO 0606
061C  66 00  V6=00
061E  67 14  V7=14
0620  A6 CD  I=06CD
0622  60 20  V0=20
0624  61 1E  V1=1E
0626  D0 11  SHOW 1MI@V0V1
0628  63 1D  V3=1D
062A  62 3F  V2=3F
062C  82 02  V2=V2&V0
062E  77 FF  V7+FF
0630  47 00  SKF V7≠00
0632  16 AA  GO TO 06AA
0634  FF 0A  VF=KEY
0636  A6 CB  I=06CB
0638  D2 31  SHOW 1MI@V2V3
063A  65 FF  V5=FF
063C  C4 01  V4=RND
063E  34 01  SKF V4=01
0640  64 FF  V4=FF
0642  A6 CD  I=06CD
0644  6C 00  VC=00
0646  6E 04  VE=04
0648  EE A1  SKF VE≠KEY
064A  6C FF  VC=FF
064C  6E 06  VE=06
064E  EE A1  SKF VE≠KEY
0650  6C 01  VC=01
0652  D0 11  SHOW 1MI@V0V1
0654  80 C4  V0=V0+VC
0656  D0 11  SHOW 1MI@V0V1
0658  4F 01  SKF VF≠01
065A  16 98  GO TO 0698
065C  42 00  SKF V2≠00
065E  64 01  V4=01
0660  42 3F  SKF V2≠3F
0662  64 FF  V4=FF
0664  43 00  SKF V3≠00
0666  65 01  V5=01
0668  43 1F  SKF V3≠1F
066A  16 A4  GO TO 06A4
066C  A6 CB  I=06CB
066E  D2 31  SHOW 1MI@V2V3
0670  82 44  V2=V2+V4
0672  83 54  V3=V3+V5
0674  D2 31  SHOW 1MI@V2V3
0676  3F 01  SKF VF=01
0678  16 42  GO TO 0642
067A  43 1E  SKF V3≠1E
067C  16 98  GO TO 0698
067E  6A 02  VA=02
0680  FA 18  TONE=VA
0682  76 01  V6+01
0684  46 70  SKF V6≠70
0686  16 AA  GO TO 06AA
0688  D2 31  SHOW 1MI@V2V3
068A  C4 01  V4=RND
068C  34 01  SKF V4=01
068E  64 FF  V4=FF
0690  C5 01  V5=RND
0692  35 01  SKF V5=01
0694  65 FF  V5=FF
0696  16 42  GO TO 0642
0698  6A 03  VA=03
069A  FA 18  TONE=VA
069C  A6 CB  I=06CB
069E  D2 31  SHOW 1MI@V2V3
06A0  73 FF  V3+FF
06A2  16 36  GO TO 0636
06A4  A6 CB  I=06CB
06A6  D2 31  SHOW 1MI@V2V3
06A8  16 28  GO TO 0628
06AA  A6 CD  I=06CD
06AC  D0 11  SHOW 1MI@V0V1
06AE  A6 F0  I=06F0
06B0  F6 33  MI=V6(3DD)
06B2  F2 65  V0:V2=MI
06B4  63 18  V3=18
06B6  64 1B  V4=1B
06B8  F0 29  I=DSP,V0
06BA  D3 45  SHOW 5MI@V3V4
06BC  73 05  V3+05
06BE  F1 29  I=DSP,V1
06C0  D3 45  SHOW 5MI@V3V4
06C2  73 05  V3+05
06C4  F2 29  I=DSP,V2
06C6  D3 45  SHOW 5MI@V3V4
06C8  16 C8  GO TO 06C8
06CA  01 80
06CC  44 E0
```

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Illustration at next page.

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- conical, head Ø 13 6 mm, head length 18.1 mm
- bud shaped, pointed head Ø 13.6 mm, head length 20 4 mm
- cylindrical head Ø 13 4 mm, head length 13.3 mm
- bud shaped, blunt head Ø 13 2 mm, head length 15 mm

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- head Ø 6 4 mm, head length 12.1 mm

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**26** **Three-piece set of steel wire brushes** with shaft Ø 2.35 mm
- disc-type brush Ø 22 mm
- cup-type brush Ø 15 mm
- standard-type brush Ø 4 mm

order No 000 63.409

**27** **Three-piece set of brass wire brushes** with shaft 2 35 mm Ø
- disc-type brush Ø 22 mm
- cup-type brush Ø 15 mm
- standard-type brush Ø 4 mm

order No. 000 63 418

**28** **Three-piece set of Chungking brushes** Chungking brushes, shaft Ø 2 35 mm
- disc-type brush Ø 22 mm
- cup-type brush Ø 12.5 mm
- standard-type brush Ø 3.35 mm

order No. 000 63 427

**30** **Ten-piece model building tool set** all with shaft Ø 2 35 mm
- Three corundum grinding bits
- Three milling bits
- Two brushes, plastic
- One felt disc on support pin
- One circular saw on support pin

order No. 000.62.439

**35** **Saw blades for jigsaw**, set of ten, coarse
order No 000 62 117

**36** **Saw blades for jigsaw**, set of ten, fine
order No 000 62 144

**43** **3 m extension lead**
order No 000 62 091
– without illustration –

**44** **Transformer adapter**
order No. 000 62 064
– without illustration –

**45** **Car adapter 12 volt**
order No 000 62 073
– without illustration –

**47** **Cup grinding wheel** made of corundum Ø 32 mm, complete with mount
order No 000 63 623

**48** **Grinding disc**, set of three, Ø 40 mm
order No 000 63 632

**49** **Sandpaper**, self-adhesive, circular, set of ten Assorted fine, medium and coarse, O 40 mm
order No 000 63 641

**50** **Saw blade for wood** Ø 32 mm, complete with mount
order No 000,63 669

**51** **Saw blade for metal** Ø 32 mm, complete with mount
order No 000 63 678

# index 1981

## AUDIO



## COMPUTERS



## ELECTRONIC TECHNIQUES



## GENERAL



## IDEAS FOR EXPERIMENTERS



## LAB NOTES



## PRODUCT TESTS

## PROJECTS



## SCIENCE



## SHORT CIRCUITS



## VIDEO



## NOTES AND ERRATA 1981

**January '81, Lilliput Computers:** There is a typographical error in the program listings on page 73. In the 'Great Circle' program, line 720, J$D=DEG D, should read J$:D=DEG D. In line 750, the 'COX' in the equation should be COS.

**March '81, Ideas for Experimenters:** A rather obvious, but potentially dangerous error occurred in the circuit on the top left of page 60 ('Power Monitor') in the March issue. It shows the mains active input connected to the earth at the output. The mains active input should instead go to the fuse. Correct your copy now. Correction slips were inserted in the majority of copies distributed.

**February-March '81, Back Door Into BASIC:** In **February, p.95, Figure 3:** Table entries have variable subscripts in reverse — e.g: E(2,1) should be E(1,2). In **March, p.113:** In the centre column, the 16th line from the bottom should read "result of 'A*A=3*3 and A›0' will be". In **March, page 109:** Line 90 should be 'R=V3/I'.

**March '81, The Negative Ion Generator:** The caption beneath the chart at the top right of page 17 contains an error. The fourth line should read ". . . balanced positive-to-negative ion ratio of 1.2:1.0 . . . ".

**May '81, Wordsquare — game for the TRS80, p. 108:** This program was obtained from our UK proteges and contains an error we didn't spot — brought to our attention by P. Chapman of Auckland, N.Z. Line 550 of the Program Listing should read

550 S$(R2(I), C2(I))=MID$(W$(W1),I,1)

and all should be well.

**Lab Notes, July, pages 63-65:** This article was reprinted from our British counterpart and, while predominantly accurate, something has gone seriously amiss at the end following the heading 'Matched-resistance attenuators'. The article at this point is quite wrong. It would take too much space to correct the problem here, so we suggest you ignore this section, which includes Figures 8 and 9. We have not had difficulties with Ray Marston's material previously, and while material is generally checked for accuracy, drawing and typographical errors, etc, this one slipped through. ▶

**Programming in CHIP-8, Nov. '81:** The procedure for loading on cassette (in box, p. 116) has an omission. The load procedure should read:

| | | |
|---|---|---|
| 'RESET' | '06' | 'STEP' |
| '0' | 'STEP' | '25' |
| 'STEP' | '00' | (or you could put FF here) |
| '0400' | 'STEP' | 'RESET' |
| 'STEP' | '07' | '4' |

**Project 159, Dec. '81:** On page 37, the text mentions Project ETI-316, where we mean the ETI-326, published in the September '80 issue.

**Project 477, Jan. '81:** In the circuit diagram for the **ETI-477 MOSFET Power Amp Module,** page 24, capacitors C7 and C8 were shown connected between the gates of Q9 and Q11 respectively, and the feedback line. In fact, they connect between the gate and source of each device, as shown in the Feb. issue.

In the **February** issue, under How it Works, there is a typographical error in the second last sentence, third column. It reads "Transistors Q4 and Q5 therefore form the main voltage gain section of the amplifier . . . ". It should read "Transistors Q6 and Q8 . . . ".

The ETI-477 MOSFET amp is not unstable if you build it the way we described. However, some readers have reported difficulties with the amplifier going into high frequency oscillation. There are two reasons for this. If capacitor C9 (220n greencap) has a high self-inductance it will not look like a capacitor, the amplifier output will be unloaded at high frequencies and oscillation will result. We found 'Elna' 630 V greencaps have a low inductance and the amp is not unstable using them.

Secondly, if resistors R25 and R27 have more self-inductance than the 'Noble' types we used, then the output stage may be unstable. There are two cures for this one. Either replace R25 and R27 with Noble types or connect a 47n greencap between the sources of Q9 and Q11. This is best done on the copper side of the board, mounting the capacitor between the two pads where the leads of each resistor go to the sources of Q9 and Q11.

**Project 567, April '81:** On page 38 is the pc board for the ETI-567 Core-Balance Relay. Just in case you hadn't noticed, look carefully and you'll see the writing on the potcore and the transformer is laterally reversed. The picture is shown correctly on page 12 of the May '81 issue.

That wasn't the only thing the wrong way round. The two red wires from T2 (L1) are shown incorrectly on the overlay, page 39. Transpose them for correct operation. The How it Works is correct, but the dot on the top wire of L1 on the circuit should go on the lower wire.

A reader has drawn to our attention a problem he experienced when using the core-balance relay with a long lead plugged into its output where a number of fluorescent lights were operating nearby. The core-balance relay would not trip on test with loads over about 25 watts. On investigation, he found severe RF noise, generated by the fluorescent lights, was preventing the unit's trip circuit from functioning. Looking at each end of L3 (secondary of T2, the sense transformer) using an oscilloscope, he found high amplitude noise on each, but of markedly differing amplitudes. The cure is simple — a 4n7 capacitor connected directly across L3. The unit still functions as designed, even with highly inductive loads plugged into the output. Our thanks to Bill Waters for passing that on.

**ETI-660 Learner's Micro, Nov. '81:** In the circuit diagram on page 37 the data buss lines adjacent to pins 26 to 33 of IC5 are shown in reverse order; D0 goes to pin 26, D7 to pin 33. This reverses the data out signals from the 6821, but it's all taken care of, so do not worry, my little chickens. Note that, on page 39, the circuit shows the 1864 as IC3 when we all know damn well that it's actually IC4.

On overlay drawings numbers 4 and 5, pages 31 and 32, IC20 is shown as a type 74LS00. It should be 7475. Also, on overlay drawing #5, p.32, the link near IC8 is shown as LINK 2 when it should be LINK 3. On the circuit, pages 36-37, the designations for diodes D5 and D6 are reversed. The **upper** diode is D6. The note relating to D5, D6 is correct.

**Project 685, 2650 S100 Computer; December '81:** In the parts list, the power supply input bypass tantalum capacitors were erroneously specified as 6 V types. They should be 35 V types — these are capacitors C2, C4 and C5. Also capacitors C1 and C9 may be 6 V or 10 V tantalums, but capacitors C6 and C7 should be 15 V or 25 V types.

**ETI-728 UHF TV antenna, March, pages 41-43:** The text states the folded dipole was constructed of aluminium strips 3 mm thick by 12 mm wide, while the diagram on page 43 shows the width to be 25 mm. It is in fact 25 mm wide, but this dimension is not critical and either strip width will work.

**Project 824, Dec. '81:** The power transistor, Q1, used in the Slot Car Power Supply is an MJ2955, not a 2N2955. On the overlay, page 29, R3 is shown as 830R, but is really an 820R, as in the circuit and parts list.

**Series 5000 Preamp, Oct. '81:** The 400 Hz oscillator set-up procedure is as follows, not as per page 12 in Dec. '81. Take your multimeter, set to read ac volts, and connect it to one of the output sockets. Se the TAPE switch to OSC. and adjust RV4 to obtain 1.2 Vac (RMS) on the meter.

# Satellite-to-home TV receiver — development promises low cost

Home television sets could soon be picking up broadcasts directly from satellites. Scientists in France have designed a low-cost microwave receiver that will need only a low-cost 1 m antenna to be commercially feasible.

**The research effort was stimulated by experiments with the European Orbiting Test Station and the Japanese satellite Yuri, which confirmed that high-power geostationary craft transmitting at 12 GHz could provide sufficient signal-to-noise ratio for a quality picture.**

To gather further data on the concept, France and Germany plan a joint 1984 launch of two preoperational 12 GHz satellites.

The envisioned system will comprise outdoor and indoor units, according to the design from the Laboratories d'Electronique et de Physique Appliquee in Limeil-Brevannes, near Paris. The heart of the outdoor unit is an amplifier — actually a gallium arsenide metal-semiconductor field-effect transistor (MESFET) — that is not only state-of-the-art but by now is also practical for the consumer market.

The high-cost, high-technology requirements for satellite-to-home TV broadcasting have been designed into the satellite side of the link, so that the specifications on the receiver end are relaxed — cutting the consumer's cost considerably.

Although cost counts, the absolute measure of any receiver is its capacity to present high-quality TV pictures on a standard TV set. Subjective as this criterion may be, it can in fact be defined in terms of a measurable signal-to-noise ratio at the TV receiver's figure of merit, which is given as 16 dB. Consequently, the minimisation of the noise figure of any 12 GHz down-converter is fundamental to the receiver's performance.

There are four basic functions performed in the receiver's front end. These are 12 GHz filtering and low-noise amplification (which is optional), 11 GHz stable oscillation, conversion from 12 GHz to 1 GHz, and 1 GHz IF amplification. One system design option involves the use of the same active component to perform all three radio frequency functions.

In the Philips systems, MESFETs are used in the low-noise amplifier, the mixer, and the local oscillator. In each function, the single-gate MESFET presents particular advantages. It offers low noise in the amplifier stage, conversion gain in the mixer, and excellent temperature stability in the local oscillator.

The local oscillator is particularly steady when it is stabilised with a barium titanate dielectric resonator with the added compensating technique of voltage-controlled output power.

The unit is housed in a moulded, metalised plastic shell. The moulding approach was adopted to minimise the hardware's price and remains relatively simple since no temperature control is necessary inside the front end.

Current front-end receiver research, at LEP and elsewhere, is directed towards a monolithic version of the FET front end, where all the active components and some RF circuitry will be integrated on the same GaAs chip. This greatly reduces mounting and adjustment time and eliminates other time-consuming assembly operations.

This approach is conceivable today because of progress in GaAs techniques that can create large and reproducible GaAs wafers. However, the cost and material limitations of high-Q circuits, temperature-stable material, GaAs real estate costs and production yield are considerations that ultimately will determine the degree of monolithic integration.

The 1 m dish soon to be a common suburban sight?

## Solid-state compact video camera

**The Sharp Corporation has developed a lightweight, compact and easy to operate solid-state video camera incorporating LSI technology.**

Conventional video cameras use a pick-up tube (a kind of vacuum tube), which poses the following problems:

- the pick-up tube is long, thus increasing the camera's size.
- high power consumption needs frequent battery replacement.
- true colour reproduction is impossible when videotaped under low illumination (100 to 200 lux).

Sharp has now developed a semiconductor device that replaces the conventional pick-up tube by using VLSI and opto-semiconductor technology.

This semiconductor device contains approximately 200 000 picture elements on a 10 mm x 8.4 mm silicon semiconductor chip. Called CCD (Charge Coupled Device), it converts a light signal into an electric signal.

A video camera using this CCD is said to feature:

- compactness and light weight, providing easy operation equal to that of an ordinary camera.
- true colour reproduction is possible even when videotaping under low illumination (approx. 60 lux interior brightness).
- no picture distortion, residual image or sticking occurs.
- the semiconductor ensures stable pictures even when subjected to vibration or shock.
- semiconductor mass production will result in future cost reduction.

The Sharp Corporation in Australia says it is too early to predict when the unit will be available.

## Denon's 'ultimate turntable'

**Although the specifications of many state-of-the-art turntables are excellent, external factors still play a big part in turntable performance. The problem of acoustic feedback, for example, is sometimes one of the last barriers to perfect reproduction, occurring when the sound coming through the speakers hits the turntable and the vibration is picked up by the sensitive top-grade cartridge. This vibration is then amplified and sent to the speakers in a vicious circle that can even produce hum and howl at various frequencies.**

Denon's DP-100M turntable is said to solve the problem of acoustic feedback using an intricate system of both spring and oil damping to virtually eliminate ground and air-propagated acoustic feedback. The 'Dynamic Servo Tracer' tonearm also has an elaborate damping system which includes a lamination-damped cartridge shell. The resonance cut-off point has been engineered as low as possible.

For rotational stability, the DP-100M features a high torque, three-phase ac servo motor coupled with a quartz crystal oscillator. A magnetic pulse sensing system on the inside rim of the dual construction platter constantly monitors the speed during operation.

Weighing nearly 50 kg, the Denon FP-100M is available only by special order. Contact Denon for more details.

## B&W monitors for Polygram

**The entire group of Polygram recording companies has decided to adopt exclusively the B&W Model 801 speakers as their classical music monitors.**

Probably the largest recording group in the world, Polygram includes the labels of DGG, Archiv, Philips and Decca. This means that the B&W 801 will be used exclusively for all the world's major digital and analogue classical recordings, according to John Bowers of B&W.

## Smaller and smaller . . .

**M-G1 is one of the latest additions to Sanyo's range of portable sound systems. It is only slightly larger than the cassette tape itself, and is said to produce hi-fi performance similar to many larger tape players.**

The 'Super Anti-Rolling Mechanism' ensures constant tape speed, even when subjected to rapid movement, and other features include a 'soft-touch' play control, metal tape compatibility, pitch, balance and volume controls, mute switch, and provision for two headphone inputs. Lightweight, comfortable headphones deliver powerful sound, and a separate battery case is also provided. Power is supplied by two AA size batteries.

M-G1 is available now at a recommended retail price of $166. For further information contact Mr. W. Fabiszewski, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02)436-1122.

## NAD from Falk

**Falk Electrosound have available the latest NAD Series 3000 amplifiers and Series 4000 tuners (. . . those designations seem familiar . . . Ed.) featuring matt black or matt silver finish.**

All equipment comes with a five-year warranty — fast becoming an industry standard — and matching styling. There are four Series 3000 amplifiers ranging from 30 W to 90 W output, with low distortion figures specified. There are two Series 4000 tuners featuring good sensitivity and low distortion. All equipment includes conventional meters.

Full details obtainable from Falk Electrosound, P.O. Box 234, Rockdale NSW 2216. (02)597-1111.

## Budget cassette deck from Pioneer

**As a part of their new 'Avante Silver Component' range, Pioneer Electronics have released three new cassette decks. All of them are loaded with the latest technology, and are priced to suit all budgets.**

The CT-320 is an elegantly styled slimline deck with a host of features, including the latest music search system. To operate this function all you do is touch the Play button and either the Fast Forward or Rewind control, depending on which direction the track you want is. The tape travels until it comes to the first unrecorded section of tape the machine senses; it then automatically changes into the Play mode and you hear the track you want.

Other features on the CT-320 include Dolby 'B' noise reduction to give increased signal-to-noise ratio. The CT-320 has the latest in LED displays to enable the most accurate possible recording level adjustment, and soft touch controls for easy operation.

The specially designed, electronically controlled dc servo motor ensures that performance of the CT-320 is the best possible for the price. Wow and flutter are 0.05%, which means excellent reproduction of sound, aided by a signal-to-noise ratio of 68 dB with Dolby 'B' on.

The Pioneer CT-320 cassette deck retails at $189. For further information contact Robin MacDonald on (03)580-9911; telex: 33482.

## Sophisticated Toshiba mini stereo

**Produced for the growing headphone stereo market, the Toshiba Model KT-R2 stereo cassette recorder is claimed to be an outstanding achievement in miniaturisation, combined with remarkable fidelity.**

The lightweight, compact unit features an inbuilt microphone for stereo recording, plus sophisticated tape facilities including a selector for normal, chrome and metal tapes, and a music quick-transfer system.

A separate Toshiba cassette-type FM tuner pack (98-108 MHz) is provided.

Convenient facilities include four LED indicators, a stereo/mono selector, and two pairs of headphone jacks.

Despite its compact size, the Toshiba KT-R2 delivers an output of 40 mW + 40 mW.

Other recent introductions by Toshiba in the mini stereo market include the KT-S1 cassette player and the RP-700FH stereo portable radio.

For enquiries or additional information concerning these products, contact Roger Porter on (02)922-6877.


## Single-tube camera has 450 lines

**Hitachi's new FP10 lightweight colour camera uses a single tri-electrode saticon tube to obtain horizontal resolution of 450 lines, normally only possible in cameras with three tubes. Signal-to-noise is said to be in excess of 48 dB (PAL).**

The single tube of course reduces the cost of the colour camera, and the FP10 is said to be easy to operate, with features such as auto iris, automatic beam optimiser, auto white and black balance, and +6 dB/+12 dB high gain for operation under low light level conditions.

Standard lens for the FP10 is a 10 x 1 power zoom, which can be easily adapted to rear control to provide studio facilities when used in conjunction with the optional remote operational unit and 4½" viewfinder.

Hitachi's local agents, AWA Rediffusion Pty Ltd, are hopeful of making the first delivery of the FP10 during March this year. For further information contact AWA Rediffusion Pty Ltd, 376 Eastern Valley Way, Roseville NSW 2069. (02)406-5677.

# Gale loudspeakers

## Now you can afford to have the best-for less . . .

The remarkable British made Gale loudspeakers have earned a reputation for outstanding craftsmanship and performance.

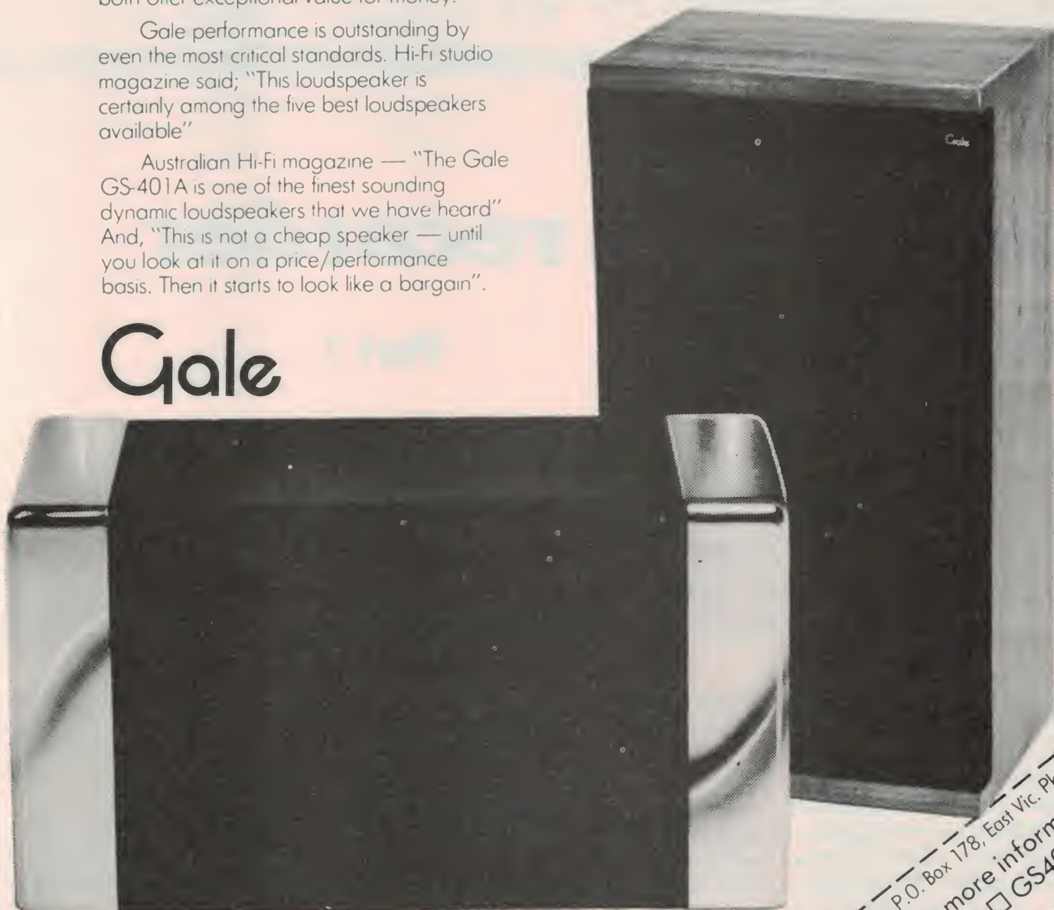
The GS-410A in striking black and chrome finish or the GS-401C concave design in conventional American walnut both offer exceptional value for money.

Gale performance is outstanding by even the most critical standards. Hi-Fi studio magazine said; "This loudspeaker is certainly among the five best loudspeakers available"

Australian Hi-Fi magazine — "The Gale GS-401A is one of the finest sounding dynamic loudspeakers that we have heard" And, "This is not a cheap speaker — until you look at it on a price/performance basis. Then it starts to look like a bargain".

**Now Arena Distributors have just received a new shipment of Gales at a reduced price. Together with an unparalleled 7 year warranty, these fine loudspeakers represent excellent value for money — so buy now and have the best for less.**

Gale

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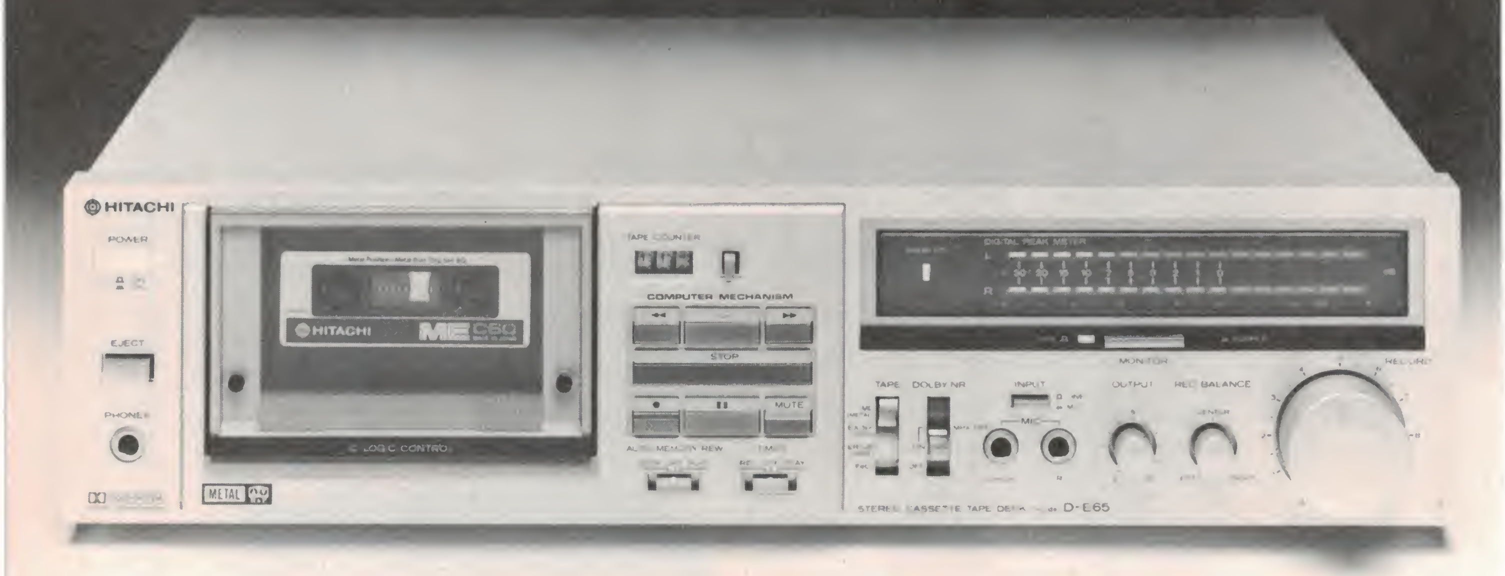



# Modern tape recorder technology

## Part 1

Reel-to-reel and cassette tape recorders released over the last few years feature electronic and mechanical facilities that offer the user incredible performance and versatility. The article covers the technology and techniques employed in modern analogue tape recorders, illustrated with partial circuits and mechanical diagrams.

**Brian Dance**

THE FIRST tape recorder to be marketed was the open-reel type (also known as the reel-to-reel), but cassette recorders are now more popular for domestic use. Cassette recorders have the advantage of convenience, since it is much easier to insert the cassette than to thread a tape in a reel-to-reel recorder. The performance of the early cassette recorders with relatively narrow, slowly moving tapes was very poor, but this performance has greatly increased with improvements in tape heads, the use of chromium dioxide ($CrO_2$) and now metal particle tapes, etc.

Nevertheless, all professional tape recorders are still of the open-reel type. This type of recorder is more expensive than a similar cassette recorder, but provides better reproduction than many cassette machines, longer playing time, and a much wider range of facilities. An open-reel recorder normally offers a choice of tape speeds, the high frequency response improving with increasing tape speed. A modern open-reel recorder may provide a response level to within ±3 dB to beyond 20 kHz at a tape speed of 19 cm/sec and a response to about 18 kHz at half this speed, with the advantage of twice the playing time. In addition, open-reel recorders enable tape editing to be performed, while master recordings can be made with a multitrack system carrying any required information on one or more of the other tracks.

Cassette decks normally operate at the single speed of 4.75 cm/sec, but there are a few recorders (such as the Teac C-3X) which can also operate at twice this speed for optimum performance.

Frequency specifications of high-quality decks vary with the tape employed; for example, Optonica quote the following upper values for their RT-7070H deck, all for ±3 dB variation: (i) normal tape 16 kHz (ii) $CrO_2$ tape 18 kHz (iii) ferrichrome tape 19 kHz (iv) metal tape 20 kHz.

Apart from frequency response, the other parameters of open-reel recorders tend to be better than those of cassette types. For example, the wider tape used in the open-reel types helps to produce a better signal-to-noise ratio; in theory the double tape width normally used increases this ratio by a factor of $\sqrt{2}$, but in practice the improvement is usually greater than this. Open-reel decks usually provide less distortion, better stereo channel separation, less wow and flutter, etc.

The continuous playing time of a cassette tape is limited by the standard size of the cassette and by the impossibility of making a very thin tape adequately strong.

## Sections of a deck

All recorders must employ a *tape transport* mechanism. The early recorders used a motor, sometimes synchronised to the mains, to drive a large fly-wheel which was coupled to the tape by means of a capstan wheel and a rubber pinch-wheel system. In some decks the same motor is used to drive the tape reels, whereas other decks use separate motors for this purpose. Thus there may be one, two or three motors in a deck. Brushless dc motors are now often used in high-quality recorders, since they generate minimum noise. In such motors a semiconductor circuit replaces the conventional carbon brush and commutator system for controlling the direction of current flow in each winding. Servo circuits (some incorporating a phase-locked loop) may be employed for accurate speed control.

The magnetic tape moves across the face of an erase head and normally at least one other head. This may be a record/replay head or separate heads may be employed for recording and replaying, depending on the class of recorder. The correct currents must be applied to the heads according to the mode of operation at the time, and many recorders employ complex logic systems for the control and switching of these currents.

The signal from a replay head is at a very low level and must be greatly amplified. In addition, frequency 'equalisation' circuits must be incorporated into both the recording and replay amplifiers so that the overall amplification of the complete record/replay system is flat across the audio range. Some form of noise reduction circuitry is almost essential for good reporduction from cassette recorders and is desirable for optimum results in open-reel equipment.

An oscillator operating at about 100 kHz is required for erasing and for providing the recording head with the bias required for low distortion.

Additional circuitry is needed to indicate (and perhaps to automatically adjust) the level of the signal being recorded so that the tape is neither overloaded (which would produce distortion) nor under-recorded (which would raise the noise level). Further circuitry is required on some recorders for adjusting the equipment for the particular type of tape employed. Thus it is not surprising that tape recorder circuitry is complex and that manufacturers are introducing microprocessor control in some models. The provision of such facilities as remote control adds further to the circuit complexity.

## Erase heads

Erase heads must efficiently erase any signals previously recorded onto the tape; they normally have a slightly wider track than the recorded tracks so as to ensure that the whole width of the recorded signal is erased. A relatively wide gap of some 100 um to 1 mm is employed in the ferrite core so that the field is adequate.

The advent of high coercivity tapes, especially metal tapes, has rendered erasure more difficult, so some manufacturers use a two-gap erase head of the form shown in Figure 1. The tape

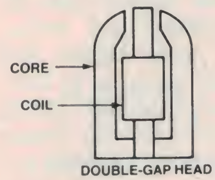
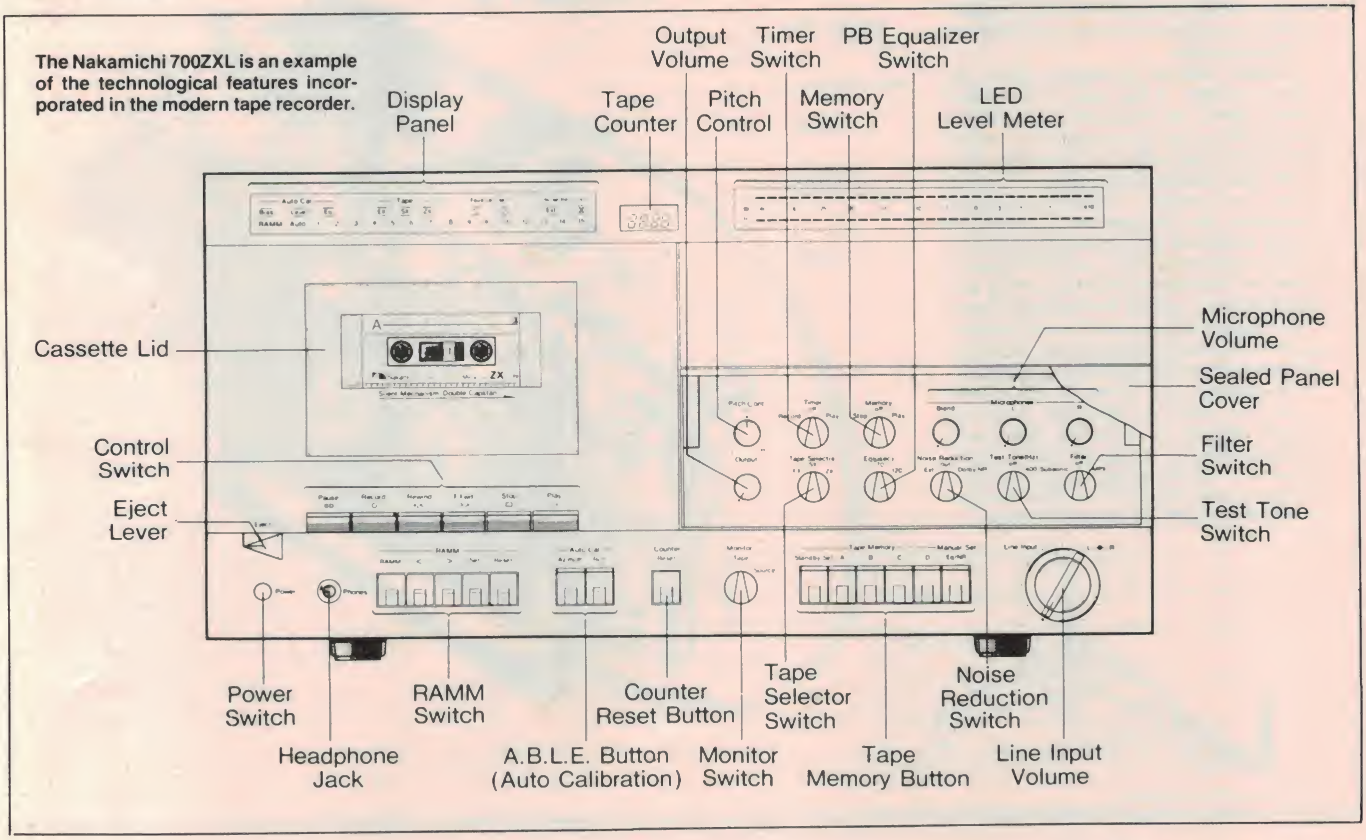



*Figure 1.* **A double-gap erase head (Teac).**

first passes across the one gap, which takes the material of the tape through several hysteresis cycles and greatly attenuates the recorded signal. The tape then passes over the second gap, which completes the erasure process. JVC employ erase heads with two gaps and claim that an improvement of some 10 dB is obtained in the signal-to-noise ratio in the case of a tape containing a 400 Hz note by the use of a dual gap head.

## Record and replay heads

A head designed purely for recording purposes usually has a gap width of between three and 30 um. However, a playback head must have a smaller gap, since this gap should be appreciably smaller than the wavelength on the tape of the highest frequency to be replayed. Gaps of less than 1 um are often used. The head is screened in mu-metal to prevent pickup of stray mains hum fields. ▶




**The Nakamichi 700ZXL is an example of the technological features incorporated in the modern tape recorder.**

Record/playback combined heads involve some compromises in their design, but are used in many cassette decks where space is limited. It is even possible to include an erase and a recording head in one unit.

Three main classes of core material are employed in record and replay heads. Permalloy (iron, nickel and molybdenum) can be employed as laminated thin sheets to reduce eddy current losses. Manganese-zinc-ferrite heads are more resistant to wear and need not be laminated, as the resistivity of the material is much higher. Many manufacturers now favour the use of a material known as 'Sen-alloy' because of its

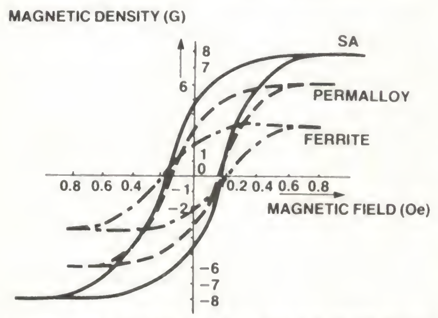



*Figure 2.* **Hysteresis loops of various tapes showing the high saturation density of JVC's SA type.**

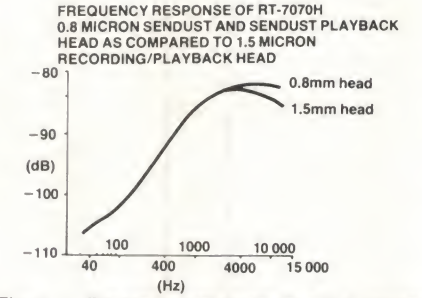



*Figure 3.* **Frequency response of a 0.8 um-gap head compared with a 1.5 um-gap head (Optonica).**

relatively high saturation permeability (see Figure 2), which facilitates the production of a relatively high field in the head gap for recording with high coercivity tape.

Sen-alloy has been known for well over 40 years, but its original form proved almost impossible to machine owing to its extreme brittleness. However, this problem has now been overcome and 'Sendust' heads are used in cassette decks by Pioneer, Optonica, etc. Accurate machining is especially important for the playback head, where the gap may be less than 1 um. The Pioneer RT-7070H cassette deck employs a recording head with a 3 um gap and a playback head with a 0.8 um gap; the response of a system with this playback head and with a 1.5 um head used for both recording and playback is shown in Figure 3.

An important factor in the choice of head material is the rate of wear, which is typically of the order of 1 um or more per thousand hours of use, depending on the tape speed. When a head undergoes wear, the gap increases, as shown in Figure 4, and this will impair the frequency response of a replay head. JVC employ six permalloy laminations in their SA heads, with a heat-bonded Sen-alloy gap/guard which has the hardness of ferrite and is therefore very wear-resistant. Permalloy itself has poor

*To page 121* ▶

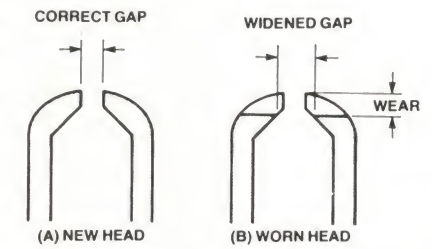


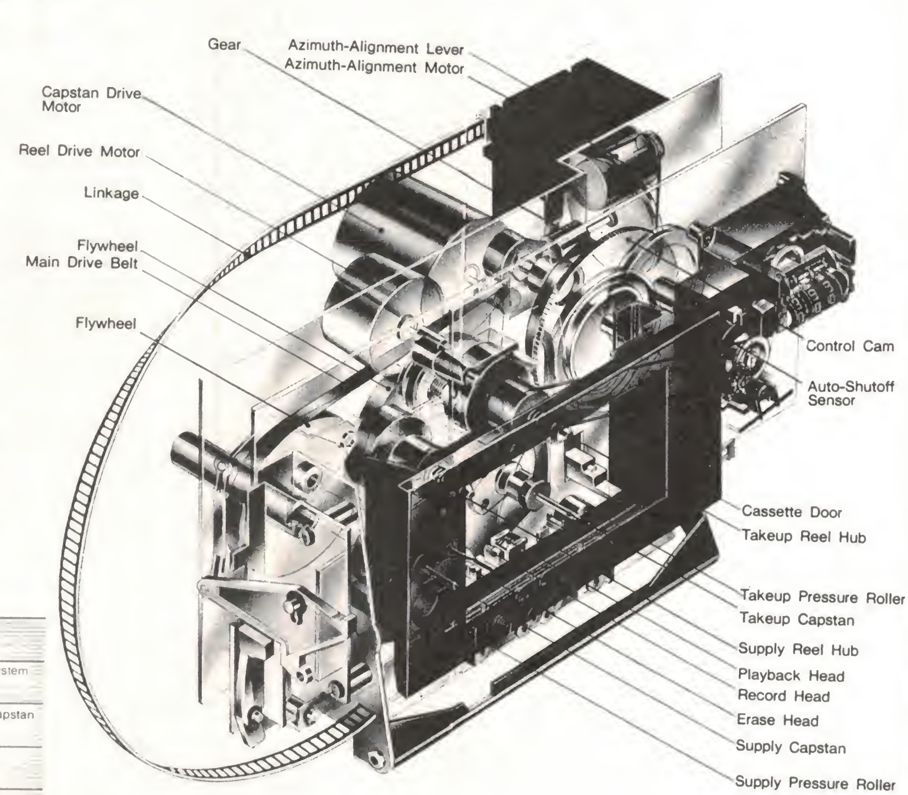

*Figure 4.* **Effect of head wear on gap width (Teac).**

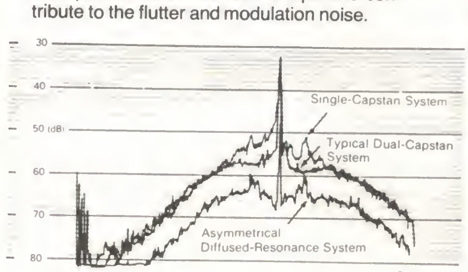
## 'DIFFUSED RESONANCE' CASSETTE TRANSPORT

Developed and manufactured by Nakamichi, and introduced barely three years ago, the 'asymmetrical, diffused resonance, double capstan transport' is claimed to reduce significantly the problems of wow and flutter and modulation noise.

Double capstan transports isolate the 'active' portion of the tape from reel-hub perturbations, but there are mutual resonances that occur that contribute to audible tape flutter, according to Nakamichi, much more than specifications suggest. To overcome this problem, Nakamichi designed transports with capstans and flywheels that rotate at different rates, eliminating common-mode resonances. Also, another source of flutter and modulation noise comes from tape vibration as it passes the magnetic heads. This partially originates with motor vibration, so the Nakamichi transport has an aluminium chassis coated with vibration-damping resin.

No pressure pad to ensure tape-to-head contact is used, as Nakamichi have paid special attention to controlling take-up and holdback tension. A tape-pad lifter is incorporated in the mechanism so that the pressure pad does not rub on the tape and contribute to the flutter and modulation noise.




Modulation Noise Analysis

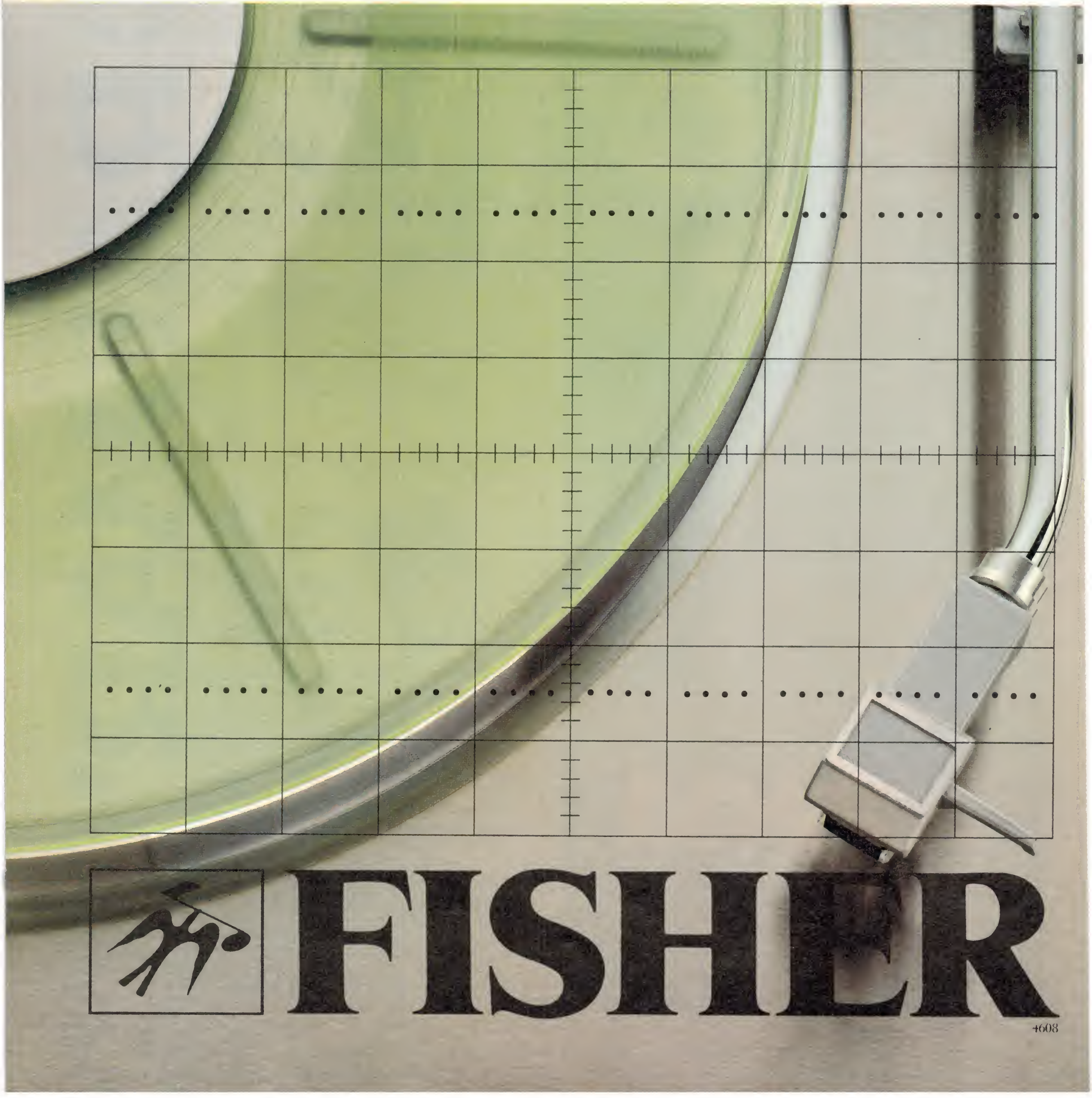
# IT NOT ONLY SOUNDS FAMILIAR, IT SOUNDS FANTASTIC.

If you were interested in hi-fi a few years ago, you'll remember the name Fisher.

Fisher made the first dynamic range expander back in 1939.

The first transistorised preamplifier/equalizer in 1956. Fisher also introduced the first stereophonic AM/FM receiver in 1959.

But if you have not heard what we've been up to lately, we suggest you get along to a Fisher retailer. At your retailer you'll find some products that not only sound familiar. They sound fantastic. **The first name in hi-fidelity.**

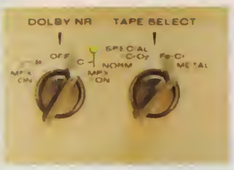


# Marantz Gold. Your New Recording Standard.


For over twentyfive years the name Marantz has stood for the ultimate in audio engineering brilliance and fidelity.

In keeping with this standard of technical excellence, the new Marantz Gold range of Cassette Decks with stunning designer element of brushed-gold finish now includes a recorder incorporating the latest in noise reduction processing.

The Marantz SD3030 Cassette Deck features the new Dolby C system to provide recordings with far less tape hiss than those made using standard Dolby B.




Unlike some other noise reduction systems, Dolby C recordings can be played back on a deck equipped with standard Dolby only without audible distortion or pumping effects.

Recording enthusiasts will be delighted by the other models in the new range.

Marantz Gold decks offer a variety of advanced features such as LED peak level meters on the SD1030, fine bias adjustment on the SD2030, and a motorized linear skating loading system on the SD5010.

*Decks shown in stack (from top): SD1030, SD3510, SD2030, SD3030 and SD5010.*
*All decks shown with TDK Metal tapes.*

*Dolby and Dolby Systems are trademarks of Dolby Laboratories, Inc.*



Distributed by MARANTZ (Australia) Pty. Ltd. 19 Chard Road, Brookvale NSW 2100
Telephone (02) 939 1900 Telex AA24121 Melbourne (03) 544 2011,
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All feature Dolby B noise reduction, compatibility with metal tapes, soft touch controls and DC Servo motors to ensure constant tape speed and silent operation.

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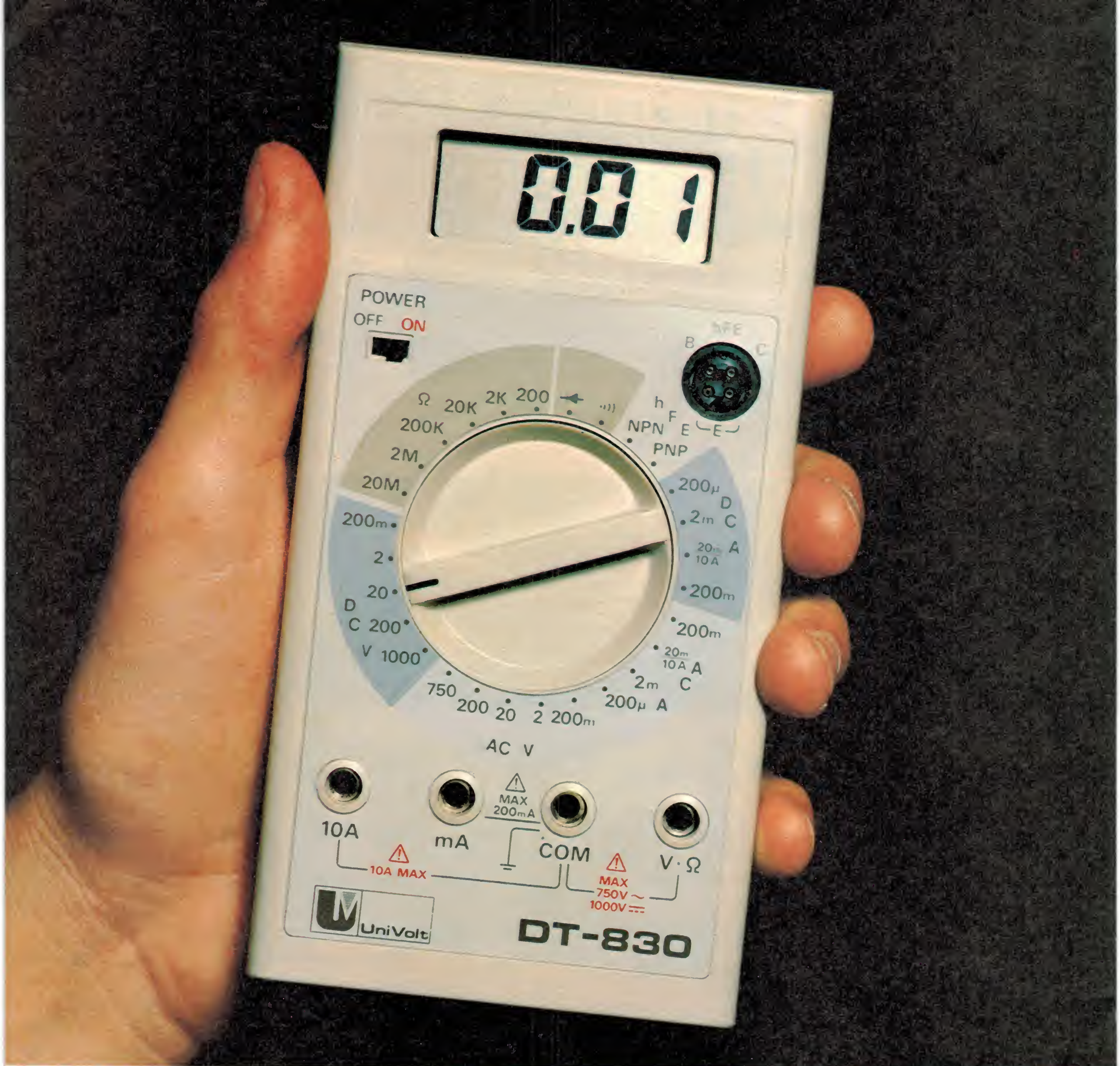


# Real measuring power in the palm of your hand


The DT830 from Univolt sets new standards for ruggedness, precision and measuring power.
The large, clear function selector shows the 830's 30 measuring ranges at a glance. The high contrast 3.5 digit LCD display gives quick, unambiguous readings. Accuracy is an excellent ±0.5% and resolution 0.1mV on the bottom DC scale. 10 amp current range and transistor tester are built in, along with an audible continuity test function for quick circuit checks.
The DT830 – your complete measuring instrument.

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Glover & Assoc IFTA/3

From page 116


Technics top-line RS-M270X cassette deck features both Dolby and dbx noise reduction systems.

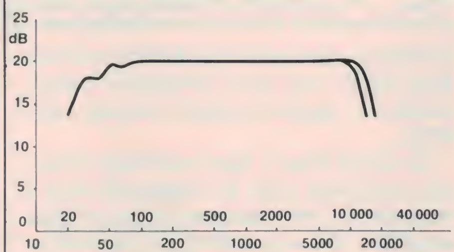



*Figure 5.* **Frequency response of JVC SA head with iron oxide and with chrome tape. Chrome tape has extended frequency response.**

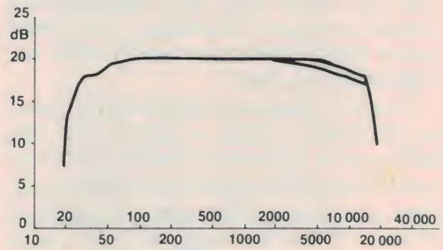
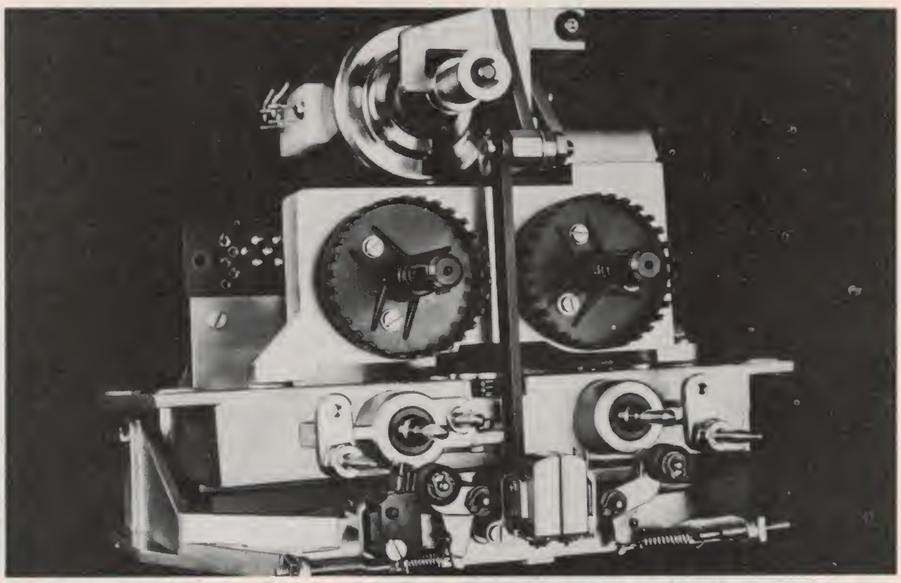



*Figure 6.* **Frequency response of the same head with the same tape types after 3000 hours' use. Note that the frequency response with ordinary oxide tape commences rolling off in the 2 kHz region.**

wear resistance. Figure 5 shows the frequency response of a JVC SA head for a normal iron oxide tape and for a chrome tape, while Figure 6 shows the same characteristics after 3000 hours' use.

## Equalisation

Let us imagine a tape has been recorded at various frequencies with the amplitude of the current passing through the recording head kept constant and independent of the frequency. When the tape is replayed, the magnetic flux in the replay head will vary at a rate proportional to the frequency. The signal voltage produced by the head is proportional to the rate of change of the magnetic flux and can therefore be expected to be proportional to frequency; that is, the amplitude of the signal from the head rises at 6 dB/octave. ▶



The interior mechanical mechanism of the Revox B710 microprocessor-controlled cassette deck. A four-motor drive is employed with electronic rather than mechanical brakes. Motor speed is controlled by two PLL circuits.

At low frequencies this rise is indeed found, but at the higher frequencies a smaller rise is observed until at very high frequencies the reponse falls off with increasing frequency. This is due to increasing losses at higher and higher frequencies in both the recording and replay process; this is admirably demonstrated by the curves of Figure 7. During recording the losses include some demagnetisation as the tap magnetised by the signal is slightly demagnetised by later parts of the signal; a self-demagnetisation loss due to the effect of nearby parts of the magnetised tape; a thickness loss arising from the fact that the whole thickness of the tape coating cannot be in contact with the head gap; a separation loss due to imperfect contact between the tape and the head gap; and eddy-current losses in the core of the head. All of these losses tend to become greater with increasing frequency.

Similar frequency-dependent losses on playback include a gap loss if the head gap is not much smaller than the wavelength of the signal recorded on the tape; a separation loss due to imperfect contact of the head gap with the tape (this is a much larger effect than separation loss on recording, since even a separation of some microns due to dirt, etc. can greatly reduce the head terminal voltage); a tape thickness loss arising from the fact that only the top surface of the magnetised coating can be in contact with the head gap; an azimuth loss if the head gap is not perpendicular to the direction of travel of the tape; and an eddy-current loss in the material of the replay head core. These losses again all increase with frequency, as indicated in Figure 7.

The frequency response will also fall at very low frequencies where the wavelength of the recorded signal is comparable in size with the dimensions of the complete playback head.

In order to obtain an overall frequency response which is level over the required audio bandwidth, it is obviously essential to employ recording and replay amplifiers in which the frequency response of these amplifiers is suitably tailored to achieve the desired 'flat' overall characteristic. This frequency compensating process is known as 'equalisation'.

Much of the high frequency equalisation normally takes place during recording, since this results in the high frequency signals being recorded at a higher level on tape, with the result that a better signal-to-noise ratio is obtained on playback. Tape noise is most prominent at high frequencies in the form of a 'hiss'.

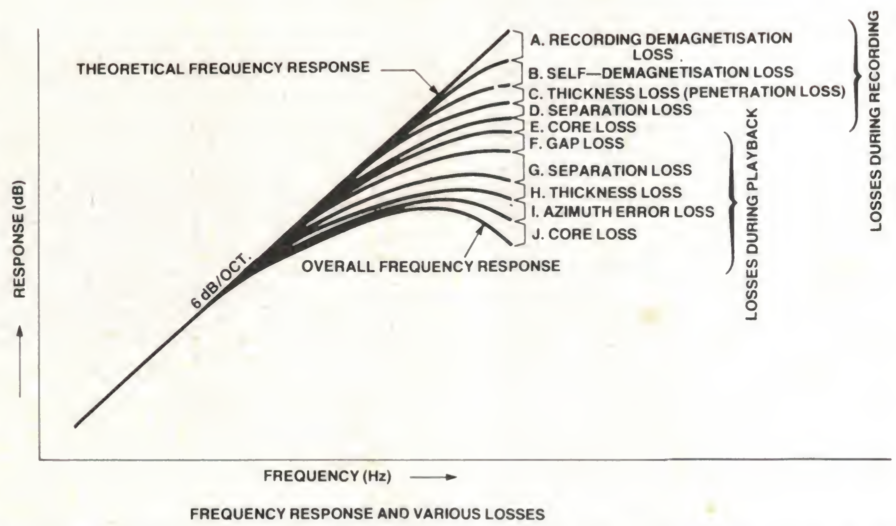



*Figure 7.* **The expected 6 dB/octave rise in recording and playback frequency response occurs over the lower frequencies, but this rolls off considerably at the higher frequencies due to various losses.**

The equalisation required varies with the tape speed, the heads used, the bias level, etc. Low frequency equalisation is applied mainly during playback.

In order that a tape recorded on any one machine may be replayed with a reasonably level response on any other machine, some standard is required for the equalisation system for each tape speed. As an example, the NAB (National Association of Broadcasters) playback equalisation standard for 19 cm/s tape speed is shown in Figure 8. It may be noted that the centre part of the curve is straight, with the 6 dB/octave fall which compensates for the rise in Figure 7. However, the response at the lower and upper parts of the curve is tailored by means of RC time constants of 3180 us and 50 us respectively. This same standard is also specified for 38 cm/s, whereas at 9.5 and 4.75 cm/s the time constants are 3180 us and 90 us to produce treble lift at lower frequencies. Somewhat similar standards have been adopted in Europe and Japan.

The standard replay characteristic is for an ideal head system, but the limitations of practical heads are compensated in the playback amplifier. Hence the characteristic of a practical amplifier is modified at high frequencies, as shown by the dashed line of Figure 8.

In practice, a tape designed in accordance with the appropriate standard is played back and the playback equalisation circuit is adjusted until a flat response is obtained at the output of the circuit. A tape is then recorded and the recording equalisation circuit is adjusted until a flat response is obtained when the tape is replayed.

It should be noted that no *recording* frequency characteristic is specified as a standard, since tape and head performance can vary considerably. Any type of recording equalisation characteristic can be employed, provided that a level overall response can be obtained when used with a standard playback system. ●

**( — to be continued)**

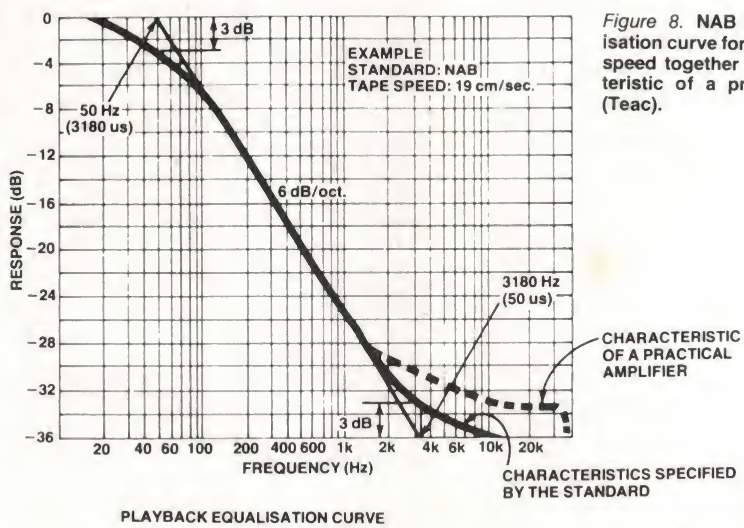
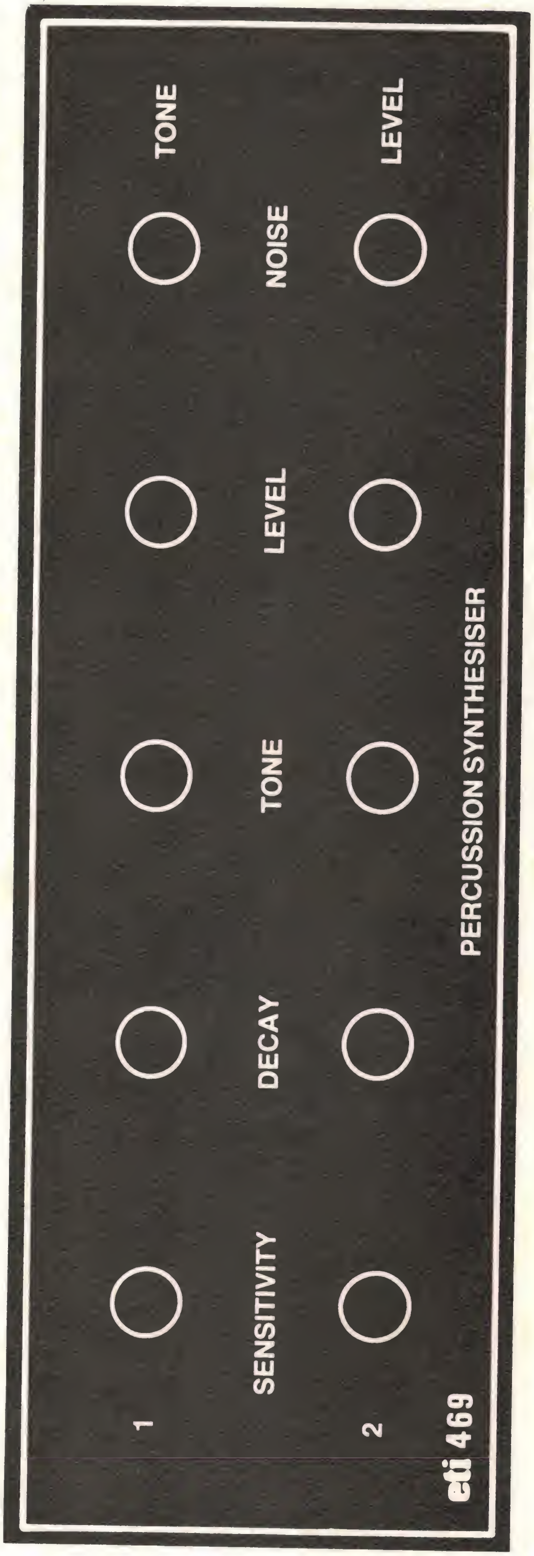



*Figure 8.* **NAB playback equalisation curve for a 19.5 cm/s tape speed together with the characteristic of a practical amplifier (Teac).**




## Using ETI PCB Artwork

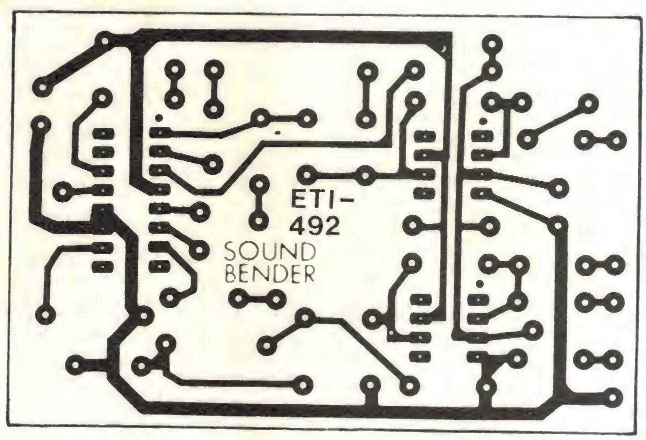
This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007, which is UV sensitive and can be used under normal subdued light.

Cut a piece of film a little larger than the pc board and expose it to UV light through the magazine page. The non-emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner — it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

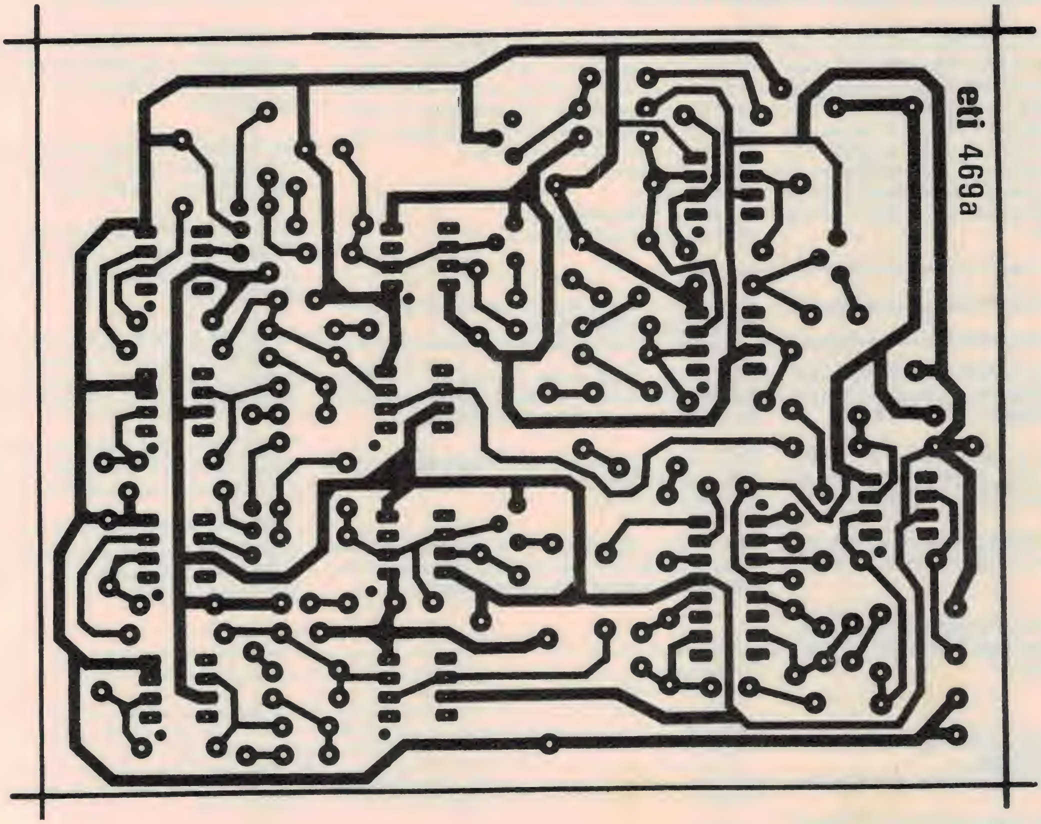
The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

Further information on Scotchcal and pcb manufacture can be found in the September and December 1977 issues of ETI.

Please note that occasionally lack of space may prohibit the printing of blue type behind all pcbs. In this case the reader must resort to more conventional photographic techniques for pcb manufacture.




February 1982 ETI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### AUDIO

SELL: Tandberg reel to reel with inbuilt power amp, $225 ono. Ring Rob for information, (03)465-6450, or write to 3 Valerie St, Lalor Vic. 3075.

JACKFIELDS, S/H, 6 mm mono, 19" rack-mounting, $10-$20. Also gramophone, wind-up console type. Ring Rod Hibberd, (02)406-5782.

FOR SALE: Escutcheon/front panel for ETI-414 Master Mixer, unused, in fair condition, $15 ono. Gary (02)337-5348.

WANTED: Thorens TD150 turntable. Any condition but must be in working order. Phone (047)21-5591 (bh), ask for Mick Hope.

### COMMUNICATIONS

FRG 7 in perfect order, 12 months old, $300. Phone W. Hancock, (08)278-1092.

SELL: One pair STC UHF/FM mobile solid-state transceivers. 10 watt + output. Suit CB/amateur use. Professional quality equipment. Make a reasonable offer. (02)29-7708.

### MISCELLANEOUS

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SELL: BWD 539D dual trace oscilloscope, dc — 25 MHz with probes and manual. Perfect condition. $500. (03)338-0521.

FOR SALE: 150 ohms 5% 25 watt resistors, c/w mounting feet. Quantity available 275, as new condition. IRC type DH. Ring (02)602-8657.

### COMPUTERS

DREAM 6802 with 3 amp p/s, some minor bugs, $175 ONO. S. McCormack, 437 Anzac Hwy, Camden Pk SA 5038.

SELL: Shugart 5" floppy disk drive, brand new in carton, $250. McLean, 6/34 The Trongate, Granville NSW. Phone (02)682-4015 or 682-0324.

SALE: Sinclair ZX80 with transformer, space wars and two other tapes, three books. Works perfectly, $195. Bennett, 6 Barilla Court, East Burwood Vic. (03)232-9001.

SELL: Super-80, 16K, complete with all IC sockets. Ready to use, tape and books, cables — urgent sale. $380 ono. (02)522-9699.

ZX80, 4K + 8K ROM, tape player (Tandy CTR41), three manuals, two books, four newsletters, p/s, programs (Breakout, etc). Cost $500, sell $250. (03)725-7284.

PET COMMODORE 2001-8, as new, 8K RAM, green phosphor screen and cassette unit plus as much software as you can carry (on cassettes and magazines). $700 or best offer. (02)517-1407.

TELETYPE KSR35, excellent condition, 20 mA I/F, $200 ono. Also full set manuals for teletype mod. 32/33, $25 ono. Norm (03)534-1192.

COMMODORE PET 2001, 8K, inbuilt VDU and cassette. BASIC course on tape; excellent condition. $500 ono. 13/96 Burns Bay Rd, Lane Cove NSW 2066. (02)428-2191.

# Technics RS-M230 fully automated tape deck

If you want good performance but don't wish to be bothered with all those fiddly adjustments for tape type, bias, etc, that the dedicated audio buff just loves, then the Technics RS-M230 fully automated cassette deck could be just the thing for you. It offers excellent performance as well!

**Louis Challis**

**TECHNICS RS-M230 TAPE DECK**

| | |
|---|---|
| *Dimensions:* | *430 mm wide × 119 mm high × 293 mm deep.* |
| *Weight:* | *5.1 kg* |
| *Price:* | *$329* |
| *Manufactured:* | *In Japan by Matsushita Electric Corporation, Osaka, Japan.* |
| *Distributor:* | *National Panasonic (Aust.) Pty Ltd, 95-99 Epping Rd, North Ryde NSW 2113.* |

THE TREND in the design and manufacture of cassette recorders is constantly changing as each Japanese manufacturer vies with his competitors to produce new features and various options to pander to the taste of the public, whose whims and desires have proved to be equally fickle.

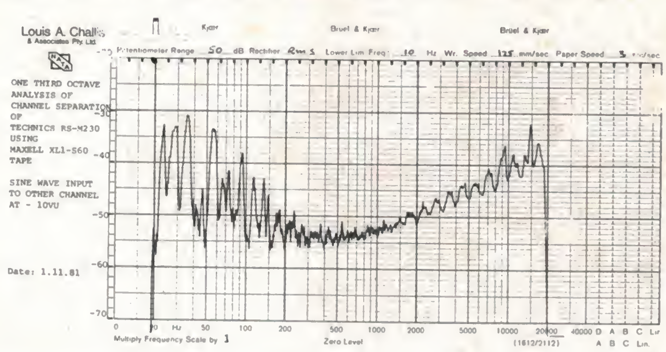
If one leaves aside machines catering for those audiophiles who are looking for more powerful and more potent characteristics in the form of microprocessors and various control functions, one soon gains the impression that the Japanese designers are seeking to produce machines designed for lazy people. These contain automatic or automated functions to allow even the most non-technical user to utilise the machine with the least possible effort, this effort being limited to placing the cassette in the machine and adjusting the volume for record or playback. Obviously if the machine is capable of selecting bias, equalisation and all other functions automatically, one has a machine which will satisfy the needs of the laziest members of our society and obviate the problems of those people who unreservedly claim they are incapable of mastering the 'complex techniques' of correctly using a conventional cassette recorder.

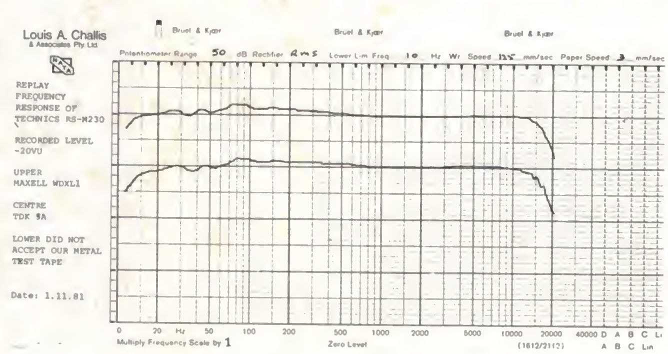
## The RS-M230

The RS-M230 cassette deck incorporates a microprocessor to simplify operation, so that the selection and determination of bias and equalisation is automatically detected from the cassette body, so long as the cassette is correctly encoded with indents on the actual cassette body.

The deck contains, on the left hand side, a power 'on/off' switch and a cassette ejection button, a socket for headphones and a cassette well with a large clear removable acrylic front panel. In the centre of the deck is a three-digit counter, below which are a series of large microswitch touch buttons, with large buttons (or larger than normal buttons) being provided for pause, play and stop, and smaller buttons for record, record/mute, fast forward and rewind. A timer control function for an external timer unit is provided on the front panel for record, off and play, whilst on the right hand side of the deck is a large plasma display covering the range −20 to +8 VU with the individual segments operating in groups of three rather than individually.

From −20 to 0 the display is white,



whilst from 0 to +8 it is orange. Below the plasma display are three lights which indicate the automatic selection of gamma ferric oxide, chromium dioxide or metal tape, but which, as we found later, only function correctly if the tape cassette contains the correct slots in the rear of the individual cassette to activate the microswitches contained within the unit. The only other controls on the front panel are a Dolby in/out or FM pilot tone filter switch, a main volume control for input level and a similar control for output level, and a pair of sockets for microphones for left channel and right channel respectively.

The rear of the unit contains two pairs of coaxial sockets, a DIN socket and the mains lead, leading through to a standard 240 volt ac plug.

The front fascia of the unit is an aluminium extrusion, whilst the top is fabricated from folded steel. The sides, bottom and rear are a series of plastic moulding, which simplifies the installation, fixing and protection of all the other primary components. One interesting feature is the way that the plastic moulding has been fabricated to facilitate the reorientation of the transformers to optimise or minimise mains leakage induction into the magnetically sensitive elements, particularly the recording heads.

The unit contains one large beautifully laid-out motherboard, so that servicing become a veritable 'pushover' compared with previous generations of cassette recorders. The unit makes extensive use of large-scale integrated circuits. Special facilities are provided on two small satellite boards connected by ribbon cable and conventional wiring. These provide the electronic functions required by the plasma display functions and the motor drive electronic controls. The drive mechanism uses two motors with servo-control systems, and these incorporate a large, efficient flywheel to assist regulation and a combination of plastic mouldings and light gauge steel fabrications to create a solid and reliable drive system.

## On test

Technics inexplicably provided us with three sample tapes for our evaluation and the full significance of this did not make itself apparent until we actually started to conduct our tests. Whilst the standard gamma ferric oxide and chromium dioxide replay frequency test tapes that we normally use worked perfectly on the unit, our metal replay tape (circa 1980) would not function on this particular unit as it lacked the appropriate slots on the back. The frequency response on gamma ferric oxide and on chrome equivalent tapes is exemplary, the frequency response being ±2 dB from 12 Hz to 17 kHz on the gamma ferric oxide, and equally flat and smooth with the TDK SA test tape. Whilst we recorded the replay response with the metal tape, this was incorrectly equalised on playback and therefore provided a ±3 dB response from 18 Hz through to 17 kHz. It is clear that the overall linearity on the metal tape would have been equally as good if not better than that provided by the other two reference tapes.

The lesson of course from this is that if one intends to use such a machine with either pre-recorded metal tapes or any tapes recorded on another machine, it is essential that they contain the features provided by the latest tapes in terms of the knock-outs or slots to provide the correct performance.

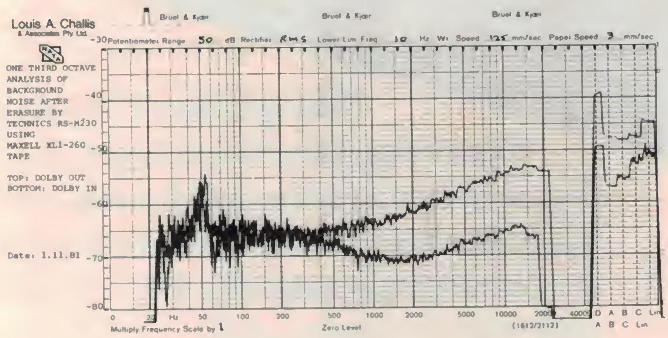
The record to replay response of the machine is not as good as its replay response but still provides good performance, being ±3 dB from 45 Hz to 17 kHz on MAXELL XL1, 45 Hz to 17 kHz on Technics RT60XA and 45 Hz to 17.5 kHz with Technics Metal RT60Mx.

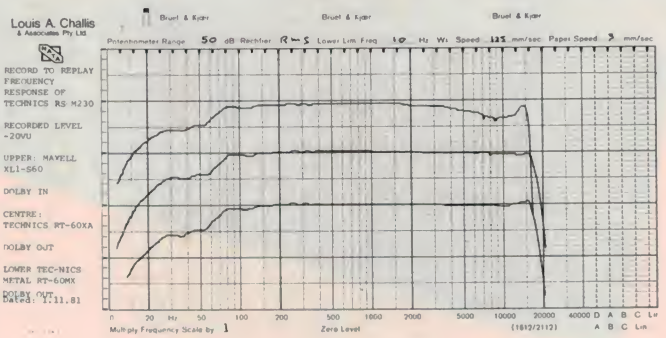
The difference between Dolby in and Dolby out is significant on this machine. With Dolby in the frequency response is not as flat as it is with Dolby out, and the saturation characteristics of the Dolby processor do leave their mark on the overall linearity at both medium and high recording levels. Nevertheless, the performance shown with the MAXELL XL1 tape indicates that the saturation level even at 0 VU on this machine is better than on many previous machines that we have evaluated.

The noise figure is particularly good, being 56 dB(A) with Dolby out and 65 dB(A) with Dolby in. These performance figures are good considering that they are for Dolby B and not Dolby C. One wonders whether a machine offering the best possible performance with Dolby B partially negates the need for more sophisticated and expensive noise reduction systems.

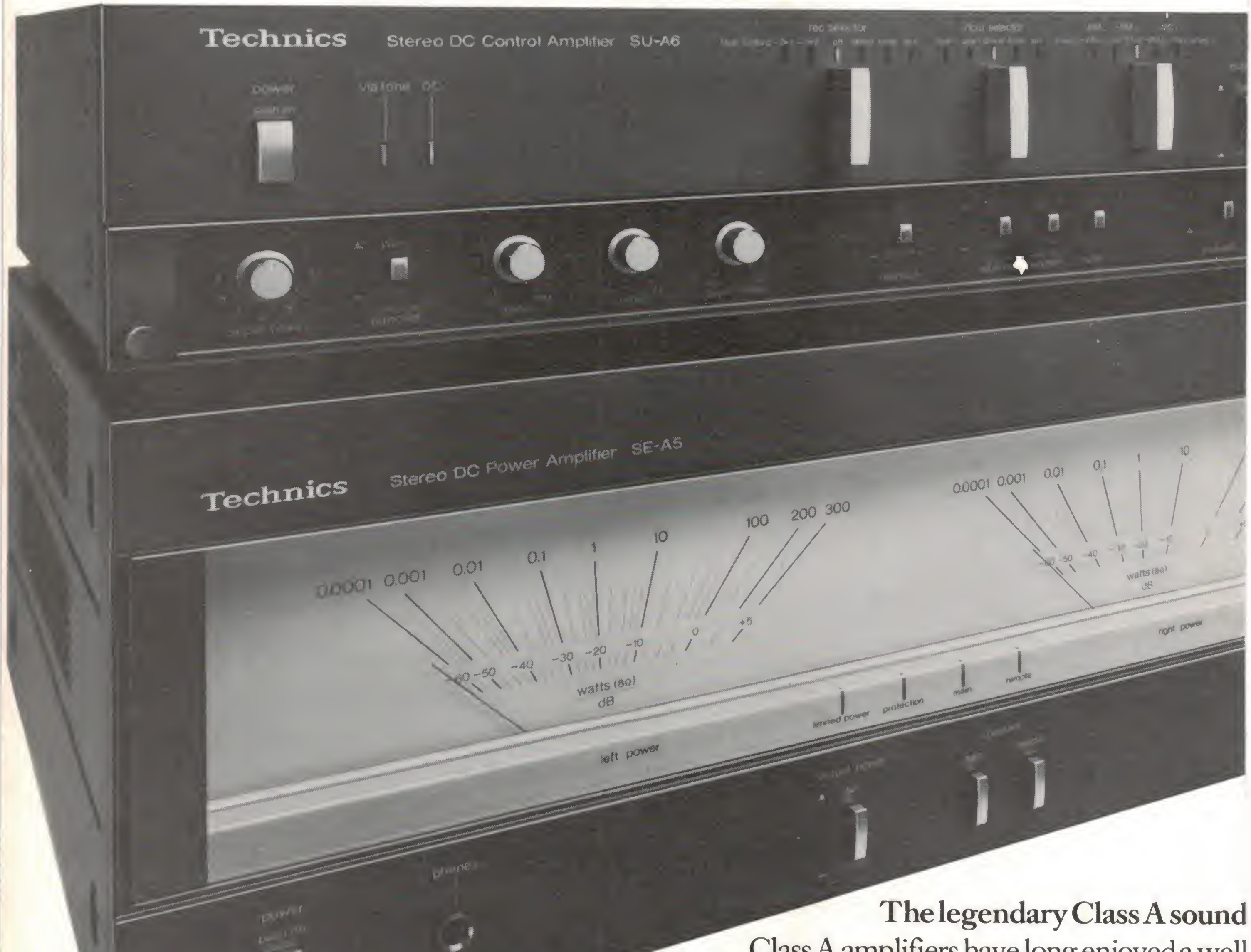
It is worthy of note that the primary components detected in the third octave noise spectrum are particularly smooth, and only the 50 Hz component shows up at all above the general electronic noise produced within the machine. This level is remarkably low and shows that the designers have taken care of mains leakage hum from the transformer and power supplies through to the associated electronics.

Channel separation is also good and at mid-frequency is better than 55 dB, only rising up to approximately 35 dB at the high frequency end and just over 30 dB at the very low frequency end. The distortion characteristics at 0 VU are also low, being 0.39% at 100 Hz, 0.05% at 1 kHz and 1.35% at 6.3 kHz. At −6 VU these figures have dropped dramatically to only 0.2% at 100 Hz and 1 kHz and 0.6% at 6.3 kHz. With MAXELL gamma ferric oxide tape the 3% third harmonic distortion is produced at +8 VU. The erasure ratio is also a very healthy −82 dB with gamma ▶



# Why did Tec
# New Class A




**The legendary Class A sound**

Class A amplifiers have long enjoyed a well deserved reputation for superb sound quality. Their drawback has been the comparatively low power output capability due to the sizeable amounts of heat generated.

# hnics develop amplification?


**The efficiency of Class B.** Since the advent and development of inefficient speakers requiring more powerful amplifiers for adequate driving, another class of amplifier has become almost universal in its application – Class B.

Certainly, in respect of its power producing capabilities, this system is without peer.

However, Class B circuitry also has its drawbacks, namely crossover and switching distortion.

**Technics New Class A solution.** The ideal amplifier should therefore combine the sound quality of Class A with the efficiency of Class B.

And Technics have achieved this goal with the development of their New Class A design. Now, crossover and switching distortion are things of the past – totally eliminated by Technics innovative technology.

**Linear feedback.** In spite of this valuable advance, Technics did not rest there.

Further studies on negative feedback resulted in another unique Technics development – Linear Feedback.

By using the technique of applying multiple feedback loops within the amplifier circuitry, distortion caused by amplification stages has been reduced almost to zero.

**Power amplifier SE-A5.** A superb example of Technics New Class A producing 120 watts per channel for only 0.002% THD over the frequency spectrum of 20-20,000Hz.

**Control amplifier SU-A6.** A highly advanced unit with many functions and facilities, including an 'extra' bass control – Super Bass.

This can extend the bass response by as much as an octave without causing bass boominess to adjacent bass frequencies.

Whilst major controls are located on the main fascia, all other controls are hidden behind a hinged glass door running the full length of the panel.

Technics have always been in the forefront of amplifier design.

That's why they constantly search for further improvements in quality.

And that philosophy led to the development of New Class A.

Of course all Technics components carry a full two year warranty.

**Technics**
Expanding the music experience.

Dailey/NPA112

MEASURED PERFORMANCE OF TECHNICS RS-M230

S.N.100505

RECORD TO REPLAY FREQUENCY RESPONSE AT -20VU:

| Tape | Dolby | Lower - 3dB Point | Max. Point and Frequency | Upper - 3dB Point |
|---|---|---|---|---|
| Maxell XLI-S60 | In | 58Hz | - | 16kHz |
| Technics RT-60XA | Out | 60Hz | - | 17kHz |
| Technics Metal RT-60MX | Out | 60Hz | 0.5dB/16kHz | 17kHz |

SPEED ACCURACY: -0.75%

WOW AND FLUTTER:

| | | |
|---|---|---|
| WOW: | Average | 0.2% p-p |
| FLUTTER: | Unweighted | 0.16% RMS |
| | Weighted | 0.03% RMS |

HARMONIC DISTORTION:

Tape: Maxell XLI-S60

| | | 100Hz | 1kHz | 6.3kHz |
|---|---|---|---|---|
| OVU: | 2nd | -54.0 | 53.6 | -46.2dB |
| | 3rd | -49.8 | -47.3 | -38.4dB |
| | 4th | - | - | -58.8dB |
| | 5th | -61.9 | - | -dB |
| | T.H.D. | 0.39 | 0.048 | 1.3% |
| -6VU: | 2nd | - | - | -47.0dB |
| | 3rd | -54.1 | -54.4 | -48.5dB |
| | 4th | - | - | -dB |
| | 5th | - | - | -dB |
| | T.H.D | 0.20 | 0.19 | 0.58% |

MAXIMUM INPUT LEVEL:

(for 3% third harmonic distortion at 1kHz)

Tape: Maxell CLI-S60 +8VU

DYNAMIC RANGE:

Tape: Maxell XLI-S60

| | | |
|---|---|---|
| Dolby Out | 53dB(Lin) | 56dB(A) |
| Dolby In | 59dB(Lin) | 65dB(A) |

ERASURE RATIO:

(for 1kHz signal recorded at OVU)

| | | |
|---|---|---|
| Tape: | Maxell XLI-S60 | 82.3dB |
| Tape: | Technics Metal RT-60MX | 78.6dB |

ferric oxide tape and —78 dB with metal tape.

The wow and flutter figures are particuarly low, with a 0.2% wow peak to peak, an unweighted flutter of 0.16% RMS and a weighted figure of only 0.03% RMS.

The objective testing of this machine shows it to have above average performance, with an upper frequency limit that is quite good enough to satisfy the average user — particularly so for one for whom the trouble of making fine adjustments or making specific changes in the operating procedure seems to be 'just too much'.

## To the ear

One quickly learns with this machine that provided the cassettes are of the latest generation it presents the absolute minimum of trouble in use. It could be classified as analagous to a car with automatic transmission; it is easy to use, easy to drive and the results it produces are good.

I played a large number of pre-recorded tapes, some encoded for Dolby C. Many of these were pre-recorded tapes which I produced for testing other machines. One of these tapes was the first of the Mobile Fidelity Sound Lab's pre-recorded tapes with slow speed mastering using the latest BASF chromium dioxide tape. With pre-recorded tapes of this quality the performance of the machine is truly outstanding, but the title I was sent was 'The Power and the Majesty', with choo-choo trains on one side and the sounds of a storm on the other. I believe they produce other tapes with music and only hope their fidelity is as good as the appetiser I was sent.

The RS-M230 exhibited exemplary reproduction, most of the time being comparable with many much more expensive machines with many more controls and fine adjustments.

Recording with this machine proved to be equally easy, and it occurred to me that a machine offering these features combined with the auto-record functions of the RSM51 cassette deck, (see ETI, March 1981) would result in a machine designed for the non-technical type who is prepared to record his own tapes without knowing quite how to do it.

The RS-M230 may not be a cheap machine, but it provides excellent automatic facilities for all adjustments of tape, type of tape and controls. It would even suit a disabled or a blind person, and on top of these facilities offers excellent performance. ●

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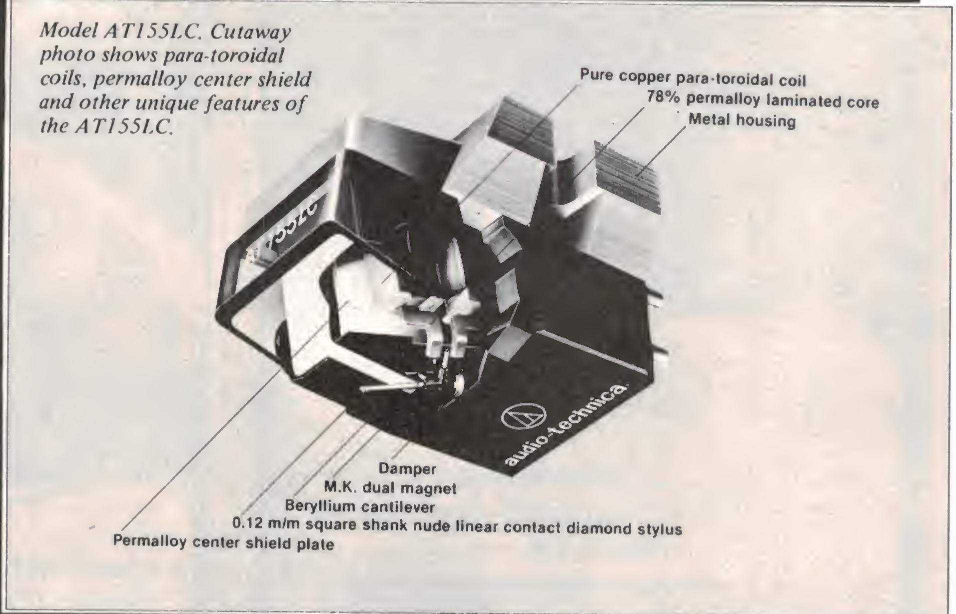
*Model AT155LC. Cutaway photo shows para-toroidal coils, permalloy center shield and other unique features of the AT155LC.*

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# Sansui TU-S33 stereo tuner


## Louis Challis

The TU-S33 tuner has been developed by Sansui to match exactly the characteristics and appearance of the AU-D22 and AU-D33 amplifiers, and for anyone living in a city radio situation, Louis Challis reckons you could do worse than this tuner for your radio reception.

**SANSUI TU-S33 STEREO TUNER**

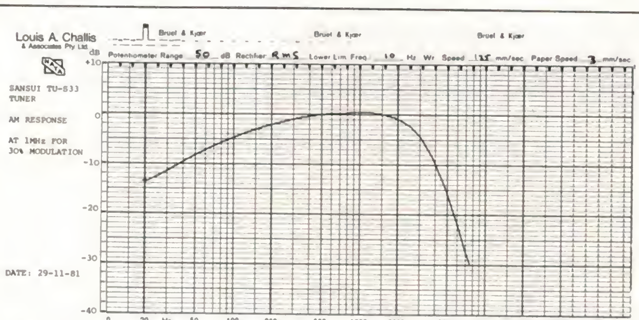
| | |
|---|---|
| *Dimensions:* | *430 mm wide x 76 mm high x 272 mm deep* |
| *Weight* | *3.5 kg* |
| *Price:* | *$269 rrp* |
| *Manufacturer:* | *Sansui Electric Co, Tokyo* |
| *Distributor:* | *Vanfi, 198 Normanby Rd, South Melbourne 3205* |

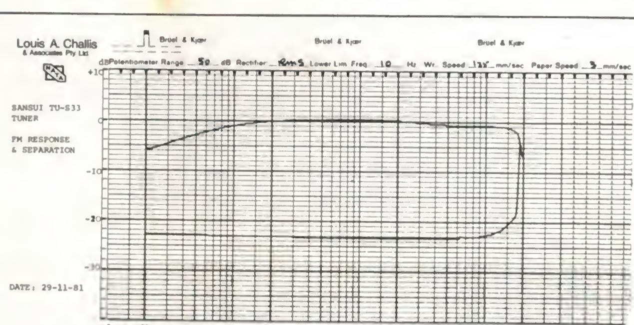
EACH TIME one of the major manufacturers releases a new series of amplifiers, it seems they feel duty bound to supplement the release with an equivalent range of tuners to match both the technical and physical characteristics of the new series. With the release of the AU-D22 and AU-D33 Super Feed Forward Amplifiers, Sansui have released an inexpensive tuner offering features that the intending purchaser should really appreciate. In keeping with Sansui's policy these have been released in both silver and black to cater for your personal taste.

### Appearance and features

The TU-S33 Servo-Locked Tuner is an attractive piece of equipment. The front panel is moulded from black plastic to minimise the manufacturing costs and features a very wide slide rule dial in the upper section, with its large tuning knob at the right hand end, and the minimal number of controls in the section immediately below. The slide rule dial is interesting and innovative, in that the frequencies are softly illuminated from behind whilst the tuning indication is provided by a little slide bar. This features a central vertical thin red LED, which is flanked on either side by triangular yellow LEDs which look like little arrows. On the FM mode these arrows indicate the direction towards which the tuning dial should be moved to correctly tune in to the station. At the correct position both arrows light up, and the yellow 'phase locked' light comes on as well. In the AM mode, one must make use of the signal strength metering facilities provided in the lower quadrant or use your hearing to correctly tune to the station.

On the left hand side of the lower quadrant is the power on/off switch. In the middle of the panel are LEDs which are, respectively, red, to indicate the



selection of an FM stereo station, five green LEDs to indicate the strength of the incoming FM or AM signal, and a yellow LED to indicate that the station has been locked in by the phase lock loop servo system in the FM tuning section. Only three other switches are provided, one for a noice canceller on/off, about which we will say more later, an AM/FM selector switch, and on the right hand end a muting mode switch which allows you to automatically mute the lower strength signals on AM or FM to reduce spurious pick-up.

The rear of the receiver features the normal balanced 300 and unbalanced 75 ohm terminals for FM reception. These terminals are supplemented by two terminals marked 'loop antenna', and lo and behold, inside the box is a small moulded plastic loop antenna complete with integral self-adhesive bracket and short leads complete with spade lugs. The loop is designed to be attached to the wall, or alternatively to be mounted clear of the receiver, to provide directional facility. For those of you who are too young to remember, back in the 30s and 40s the loop antenna was the favoured method of optimising signal strength from an incoming station whilst simultaneously providing maximum rejection for unwanted spurious signals, be they from a refrigerator, washing machine or even unwanted industrial magnetic transmission from a nearby factory.

With the development of ferrite loop antennae, the loop antenna lost favour, even though its directional characteristics are superior to the ferrite loop stick. The only other receiver that we have recently seen offering this facility was the Audio Sound Model AM.101, which provided a less attractive although in some respects more sensitive loop, with similar directional characteristics.

The only other fittings on the rear panel are the two coaxial sockets to feed through to the main amplifier, and much to our surprise an unswitched 240 V outlet, which I was sure had been banned by the Australian Electricity Supply Authority ruling.

The chassis and remainder of the cabinet are fabricated from steel, as is the rear panel, and the unit perfectly matches the physical characteristics of the AU-D22 and the AU-D33 integrated amplifiers. The inside of the unit is both simple and straightforward, in that it incorporates one large printed circuit board which has obviously been designed for a range of possible receivers. There are a surprisingly large number of blank holes, which we must presume were either designed for the matching long-wave version of this receiver, or alternatively for a similar type of receiver with higher sensitivity. The printed circuit is, however, beautifully laid out, featuring test points and clear labelling of all components, making servicing a delightfully simple task.

The most interesting feature of this unit, however, is not the electronics, but rather the mechanical system with which the slide-rule dial linkage works. This is probably one of the most complex cord drive systems we have seen for many years. It is only eclipsed by the actual method by which the power is fed through to the slide-rule dial. The unit incorporates no less than seven individual wheels over which the dial cord must pass, excluding the two separate small grooved wheels on the counterweighted drive. Obviously the designers were worried about the reliability and performance of this system, and have taken far more trouble with its design concept than in other units which we have seen in the past few years.

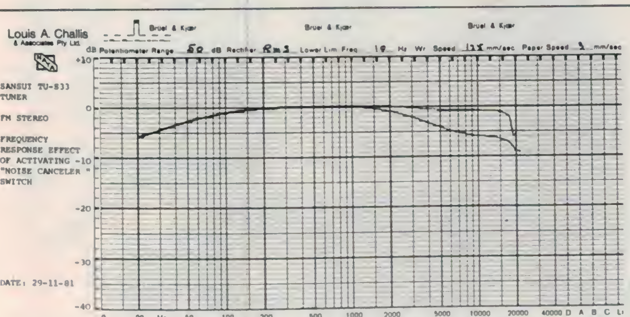
By contrast the electrical connection for the four wires leading through to the three LEDs on the dial assembly features an umbilical system which looks more like Heath Robinson that the Japanese technology we have seen developing over the past few years. The wiring harness incorporates a vertical section of plastic spaghetti, located at almost the centre of the printed circuit. From the top of this vertical stand the wires droop as an unprotected twisted harness, which is then connected to the carriage on the slide-rule dial through a stiffened section of clear plastic tubing 95 mm long. In watching this operate, I had the horrible fear that the wire harness was going to catch on one of the transistors lying in the wire's path. However, each time the dreaded problem did not arise, and the unit continued to function well. With the cover off it was a most interesting conversation piece.

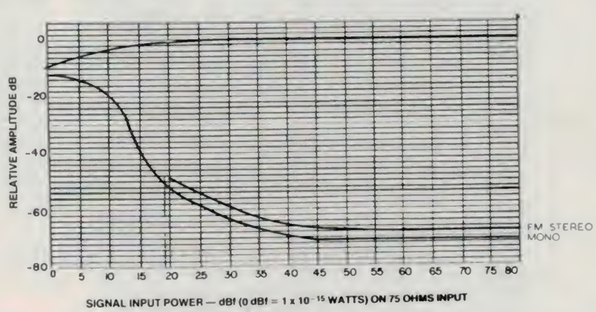
The layout and construction of the printed circuit board are typical of the latest advances in Japanese manufacturing technique, featuring the minimum number of hand-soldered connections and the maximum utilisation of pre-formed or moulded modules to minimise the manual insertion and assembly of the components both on the board and within the chassis.

## On test

The objective performance of the unit is generally excellent, although some of the figures fall short of those claimed by the manufacturers in their trade literature.

The usable sensitivity on FM mono, for 26 dB signal-to-noise ratio, is 13 dBF, which is good but not outstanding. The normal stereo sensitivity for 46 dB signal-to-noise ratio was not measureable, in that the internal threshold for the stereo signal detection occurs at 19 dBF for a 50 dB signal-to-noise ratio, which is quite a commendable figure. The ultimate signal-to-noise ratio on stereo is 68 dB, whilst that on ▶



MEASURED PERFORMANCE OF: SANSUI TU - S33

S.N.: 831090017

FM TUNER SECTION: (measured at 98Hz unless otherwise stated)

FREQUENCY RANGE: 88 - 108MHz

USABLE SENSITIVITY:
(40kHz deviation)

| | |
|---|---|
| Mono for S/N 26dB | 13dBf |
| Stereo for S/N 46dB | Not measureable due to muting |
| Stereo threshold | 19dBf @ 50dB S/N ratio |

SIGNAL TO NOISE RATIO: (see curves)
(40kHz deviation)

| | |
|---|---|
| Mono. | 71dB |
| Stereo | 68dB |

DISTORTION:

1kHz signal @ 50dBf 0.15% Stereo 0.09% Mono

FREQUENCY RESPONSE: (see curves)
50Hz - 18kHz

SEPARATION: (see curves)
23dB

AM TUNER SECTION

| | |
|---|---|
| Frequency Range | 525-1600kHz |
| ANTENNA | "True Loop" |
| RESPONSE @ 1mHz | 150 - 2500Hz |

FM QUIETING AND S/N RATIOS:

| | Mode = Mono 2m=300 | Dev = 40kHz |
|---|---|---|
| Input Level dBf | Modulated output dB | Noise Output dB |
| 800 | 0 | -71 |
| 70 | 0 | -71 |
| 60 | 0 | -71 |
| 50 | 0 | -71 |
| 40 | 0 | -71 |
| 30 | -0.1 | -62 |
| 20 | -0.2 | -51 |
| 10 | -3.5 | -18.0 |
| 0 | -9.0 | -12.0 |

| | Mode = Stereo 2m-300 | Dev = 40kHz |
|---|---|---|
| Input Level dBf | Modulated output dB | Noise Output dB |
| 80 | 0 | -68 |
| 70 | 0 | -68 |
| 60 | 0 | -68 |
| 50 | 0 | -67.5 |
| 40 | 0 | -65.5 |
| 30 | 0 | -59.0 |
| 20 | -0.1 | -49.4 |

Muting Occurs

mono is 71 dB. The bandwidth on FM stereo and mono is 50 Hz to 17 kHz, with a very sharp drop-off to the 19 kHz pilot tone. This frequency response is smooth and quite adequate for good stereo listening. The channel separation falls short of the manufacturer's claim, providing 25 dB of separation all the way from 20 Hz through to 6 kHz, dropping gradually to 20 dB at just under 15 kHz. As the channel separation on the records played by the FM stations is not significantly better than this figure, this does not constitute a serious disability in the receiver.

When the noise canceller on the front panel is activated, the top end of the frequency is attenuated by approximately 6 dB over the frequency region 6 kHz to 17 kHz. This difference in frequency response would not be readily audible unless you have sharp hearing, and does not constitute a significant disability.

The distortion characteristics on FM are excellent, and at 50 dBF signal level the distortion is a modest 0.16% on stereo and 0.09% on mono. By contrast the AM frequency response, in keeping with the majority of other tuners on the market, provides a relatively peaky frequency response, with a bandwidth of only 150 Hz to 2.5 kHz. This is suitable for pop music but not as suitable for the better quality AM transmissions available in this country.

## In use

The subjective assessment of the unit was carried out at home under conditions which could be described as typical for an inner urban situation in any major city. No FM station is closer than 8 km and no AM station closer than 20 km from the point of reception. Under these conditions only inner-city AM stations are audible during the daytime, plus closer country stations at night. All the city FM stations are readily received at adequate signal strength on a 'rabbit's ear' antenna, and the noise canceller provides no great listening advantage under these conditions. The quality of reception is excellent and the level of distortion remarkably low. The major limitation is the stations' transmissions, not the receiver.

The TU-S33 receiver is a well-designed unit, offering good but not outstanding performance, designed to provide a happy compromise between the constraints of appearance, performance and cost. For city listening this unit must rate very highly, but it is not recommended for people living distances of 25 km or more from an FM station, nor at distances of 50 km or more from the AM stations you want to hear, unless you are prepared to use an external antenna to develop the full potential of the unit.

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# DREGS


## Roger who?

The hacks who write for Dregs are currently engaged on a very special project. We're going to modify the Turtle Robot project so that it will operate on vertical surfaces. The Turtle Robot has the unique ability of being able to draw. Now, the B.U.G.A. U.P. people (Billboard Utilising Graffitists Against Unhealthy Promotions — see Dregs, June 1981) spotted this ability of the Turtle and contracted the Dregs Design Team (D.D.T.) for the special model. The D.D.T. have successfully modified the Turtle's pen solenoid so that it operates a spray can of paint mounted on board, and are currently working on a suction cap traction system so that the Turtle will crawl around vertical surfaces — rather like a fly. The D.D.T. hope to come up with the world's first 'Electronic, fly-footed, computer-driven robot Turtle'!

Hang on, it's B.U.G.A. U.P. on the phone . . . they want us to organise the software so that the robot will sign a graffiti-ed billboard with their acronym. No problem. A little routine tucked away at the top of memory, and, with a single keystroke — it signs B.U.G.A. U.P. Wait! B.U.G.A. U.P. want to change their logo! What's that? Roger who? Oh . . . R.O.G.A. U.P. — Robot Organised Graffitists Against Unhealthy Promotions!

## Electricity crisis

Amidst all the kerfuffle about the electricity crisis in New South Wales recently came this wonderful story from the land of the shamrock and the shillelagh.

Paddy wanted to reduce his electricity bill, figuring (a) it was too much, and (b) he'd have more to spend at the pub. He put a quiet word round at the local and was introduced to a certain fella who showed him how to wind the meter back. "Begorrah," he said to himself, "I'll do it straight away." Reeling his way home he got the ladder, climbed up to the meter and gave it a good twirl.

His next bill came to 600 pounds, not the 60 pounds he usually paid! Then, to add insult to injury, he was hauled before the local beak and fined a further 200 pounds for interfering with the meter. It is not recorded whether Paddy has caught up with the certain fella with the intent to interfere with him.


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